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PETROLEUM RESEARCH IN NORTHERN AFRICA[1]

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ABSTRACT

Recent investigations by the National Office of Liquid Combustibles of the French Government, with the joint support of the Compagnie Française des Pétroles and the Bureau of Researches in Morocco, have resulted in much new information regarding the geology and structural conditions in the areas favorable for commercial oil production.

This article is a brief review of the general structural features of North Africa, including summaries of the geology in the areas where research studies and exploration work have been conducted in Morocco, Algeria, and Tunisia. Although no commercial production of importance has been developed in North Africa, there are many favorable areas. Detailed geological studies will be continued and further tests drilled in an attempt to solve some of the problems concerning the occurrence of oil in North Africa.

INTRODUCTION

There are no commercially exploited oil occurrences of importance in the French colonies, though in many of these colonies natural oil indications are known and have been explored by test drilling. However, up to the present these efforts have been almost without results.

French northern Africa—Morocco, Algeria, Tunisia—should be one of the first colonies to be prospected, because of its proximity to the metropolis, its situation on the course of the Alpine chains, which in other regions contain successfully exploited petroleum occurrences, and finally because of the presence of natural oil seepages, some of which have

[1]Presented by title before the Association at the Oklahoma City meeting, March 26, 1932. Manuscript received, February 20, 1932.

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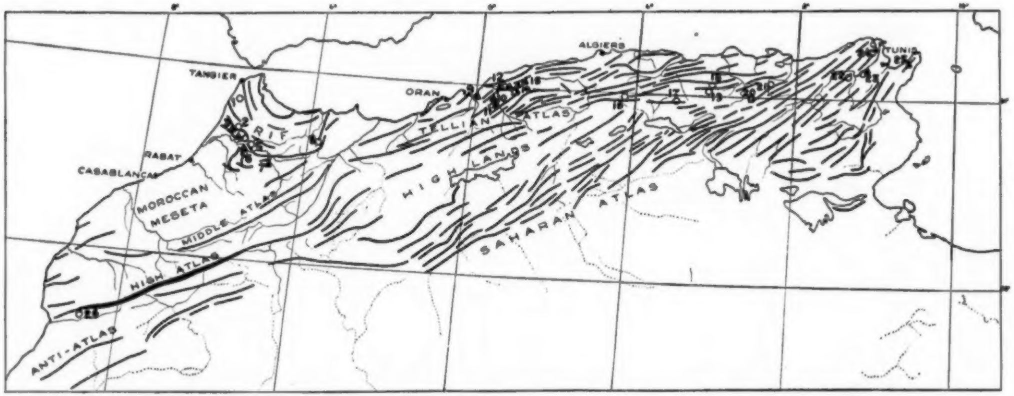

FIG. 1.—Tectonic sketch map of northern Africa, according to R. Staub, P. Fallot, Atlas d'Algérie et Tunisie, L. Pervinquière, M. Solignac, *et al.* Circles: principal oil seepages and occurrences of bituminous substances. Black triangles: principal wells or groups of wells. 1, Larache. 2, Si Hameur el Hadi. 3, group of wells at Souk el Arba of Rharb region (Ain Hamra, Sidi Moussa ben Zered, Sidi bou Mlid, Karia, Jraïffi). 4, 5, Ouergha, Khadiret, et cetera. 6, Tselfat. 7, Fez. 8, Tizeroutine. 9, Port aux Poules. 10, Bel Acel, Tahamda. 11, Tliouanet. 12, Sidi Brahmin. 13, Aïn Zeft, Oued Tharia. 14, Mazouna. 15, Rabelais. 16, Sidi Aïssa. 17, Tocqueville. 18, Fedj Mzala. 19, Saint-Arnaud. 20, Aïn Fakroun. 21, Renier. 22, Kef bou Debbous. 23, Sloughia. 24, Aïn Rhelal. 25, Cap Bon. 26, Taroudant. Length of area, approximately 630 miles.

been known since Roman time. In fact, the first attempts to prospect these regions were made 40 years ago in Algeria.

The first period of research work in Algeria extended from 1892 to 1912, but these investigations did not yield any positive results.

At the end of the World War, a new impulse was given to the research work, resulting in the drilling of test wells in Morocco, as well as in Algeria and Tunisia. The small oil field of Tliouanet was discovered at this time in Algeria.

However, the problem could not be considered as having been definitely solved, because of the shallow depth of the test wells in many of the prospected regions and because of the unsatisfactory selection of some of the locations. Therefore, in 1929, the French National Office of Liquid Combustibles decided to undertake a systematic study of the possibilities of Morocco. This was done with the support of the Compagnie Française des Pétroles and the Bureau of Researches in Morocco, and of the Belgian company "Financo." Thus, this undertaking included provision of the financial and technical means, which would eventually permit the solution of the problems. This research is at present being continued and a similar program is being considered for Tunisia.

In the following pages, the writer tries to outline the general conditions of the problem on the basis of the results of regional geological studies now published, and particularly on the basis of such studies made by Daguin, Bourcart, Yovanovitch, Lacoste, *et al.*, in Morocco, by Dalloni and Joleaud in Algeria, and by Solignac in Tunisia. As regards Morocco, the writer wishes to express his thanks particularly to chief geologist Lacoste of the Syndicat d'Études of Morocco, for much geological information, most of which has not yet been published, and for the readiness with which he communicated his important discoveries. Further, the writer desires to mention Mr. Yovanovitch, who supplied much interesting information, and Mr. Solignac, who very kindly arranged for visiting the most interesting parts of northern Tunisia. As to Algeria, Mr. Mena agreed to prepare the section concerning Tliouanet, for which sincere thanks are due him. Finally, the writer is especially grateful to W. P. Haynes, at whose suggestion the present work has been done and who offered for examination a very interesting report on northern Tunisia and southern Morocco. Moreover, Mr. Haynes has had charge of the translation of this article.

GENERAL STRUCTURAL FEATURES OF NORTHERN AFRICA

Let us consider a map of northern Africa: a striking contrast makes possible the division of this area into two parts: (1) at the south, the

Sahara table-land, and (2) at the north, a mountain chain extending northeast from Morocco into Tunisia parallel with the Mediterranean shore.

This orographic unit is very complex: it includes a series of small mountain chains separated by high uplands. From west to east, the principal mountain chains are as follows: (1) the Morocco High Atlas, the summit of which is 4,000 meters above sea-level, and which is bordered on the north by the Middle Atlas and on the south by the Anti-Atlas; (2) the Rif (northern Morocco), whose altitude does not exceed 2,000 meters and which is separated from the Atlas by the region of the elevated Moroccan highlands, known as the Morocco Meseta because of its analogy with the Iberian Meseta. In Algeria, the structure is more simple: along the coast extends the Tellian Atlas, the altitude of whose summits ranges from 1,000 to 2,000 meters, and at the border of the desert, the Saharan Atlas. Between these two chains, the Algerian highlands form a series of basins, in many places without drainage, the bottoms of which are occupied by salt lakes. Toward the east, this intermediate region disappears, so that both the Tellian and the Saharan Atlas join in the Tunisian mountain region.

Geologically, the Atlas is very different from the remainder of Africa: it is a fragment of Alpine chains which forms a prolongation, toward the southwest, of the folds of the Italian Apennines. These chains are of Tertiary age and are formed by a sedimentary sequence extending from the Triassic to the Pleistocene period and resting on a folded Paleozoic basement. In Algeria and Tunisia, there are only a few outcrops of this ancient basement, and most of these belong to the Jurassic, Cretaceous, and Eocene periods. In Morocco, on the contrary, there are large outcrops of this substratum in the Morocco Meseta, and in the core of the Atlas and Rif mountains. This substratum is composed of formations of different Paleozoic periods which have been intensely folded during the latter part of the Paleozoic era. The strike of these folds is generally northwestward, very different from the strike of the Tertiary folds.

The aforementioned large geographical divisions correspond with tectonic units which can be grouped as follows.

1.	Sahara table-land	
2.	Saharan Atlas	
3.	Algerian highlands	Atlas
4.	Tellian Atlas	
5.	Morocco Meseta	
6.	Rif	

The Sahara table-land is the rigid hinterland of the Alpine chain. The Saharan Atlas is a slightly folded area characterized by *en échelon* arrangement. Ritter[1] has compared this structure with that of certain regions of the Rocky Mountains. The facies of the Jurassic and Cretaceous sediments everywhere indicates that they are shallow-sea deposits; Eocene formations are present only in the eastern and western parts and are lacking in the central part; this region never formed a geosyncline, but remained a more or less direct dependency of the Sahara table-land. In the eastern part, the Sahara chains are incurved toward the north and form the small chains of central Tunisia, whereas in the western part their prolongation is the Morocco High Atlas, a large ground fold, the Hercynian basement of which shows large outcrops and is bordered on the south by the Anti-Atlas.

The region of the Algerian highlands extends from the valley of the Moulouya (eastern Morocco) to the Hodna (eastern Algeria). In this region the substratum successively resisted the orogenic movements, and the sediments which cover it show tabular structure. This zone corresponds with a rigid massif, around which the small Atlas chains had to mould themselves, and constitutes the Oran Meseta.

The northern part of the Atlas has a more complex structure and is divided into two zones: the seaboard Tellian Atlas and the interior Tellian Atlas. These regions correspond with a zone of geosynclinal deposition within which Cretaceous deposits are characterized by a deep sea facies.[2] Nummulitic deposits are represented here by a sandstone and Flysch facies which continues toward northern Tunisia. Finally, along the seashore several old massifs—crystalline or Paleozoic—occur between the Atlas folds and represent massifs around which the folds had to mould themselves. Toward the east, the Tellian Atlas of Algeria continues in Tunisia and, because of the disappearance of the highland zone, joins the Saharan Atlas. Then it changes its direction and, instead of extending from east to west, extends from northeast to southwest.

The Middle Atlas, formed mostly by a Jurassic zone represented by large faulted folds of a much simpler tectonic structure, is located between the Oran Meseta and the Morocco Meseta.

The Morocco Meseta corresponds with another tabular zone between the Middle Atlas and the Rif. Contrary to conditions in the highlands, Paleozoic formations crop out extensively in this region and are covered

[1]E. Ritter, *Le Djebel Amour et les Monts des Ouled Nail* (Alger, 1902).

[2]L. Joleaud, *Étude géologique de la chaine Numidique et des Monts de Constantine* (Paris, 1912). "Esquisse tectonique de l'Atlas," *XIII Cong. géol. intern., 1922* (1925).

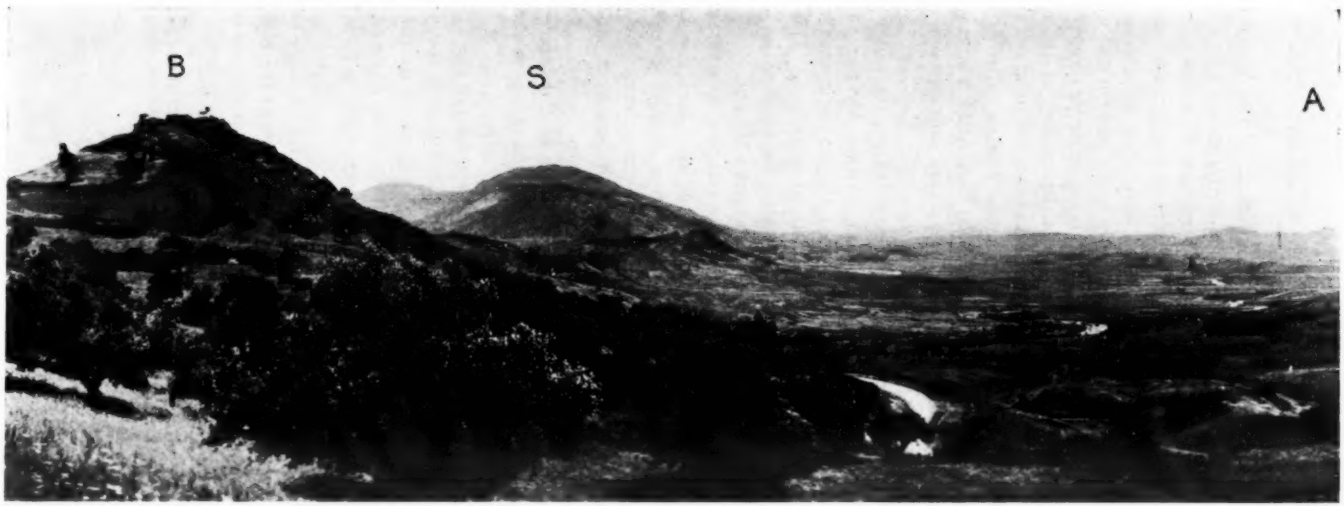

FIG. 2.—Miocene syncline of Ouergha River in Flysch zone. View taken from Taounat. At left, Cretaceous Flysch. *B*, Lower Miocene sandstones, dipping southward. *S*, Jurassic limestone massif of Senhadja, northern border of syncline. *A*, Jurassic and Flysch formations of Beni Aïcha, southern border of syncline.

by transgressing Cretaceous formations. The effects of the Alpine movements here induced the formation of uplifted areas, as the Djebilet.

Finally, the Rif is a tectonic unit, very different from the preceding units, which extends along the northern coast of Morocco from Tanger to Melilla and continues into Spain, on the opposite side of the Strait of Gibralter, where it is known as the Betic Cordillera. The systematic position of this system has been much discussed[1] and as a result of recent study, it should be considered as a unit, plunging west, the Gibralter curve resulting from an intersection of "structure" plunging in a western direction. The Betic Cordillera, which is very complicated, corresponds with a zone of frontal dislocations of this unit.

Toward the coast, the Rif includes a crystalline zone covered by a series of Jurassic and Lower Cretaceous deposits, which form the principal summits. Beyond this, there is a zone of Cretaceous-Eocene Flysch, and finally the Miocene region of the Rharb. South of the Flysch zone and rising from the foreland appear the folds of the Pre-Rif, which are large Jurassic anticlines, resulting from a deformation of the border zone of the Meseta.

The age of the Atlas dislocations is not the same in all places. Apart from the Hercynian movements which affected the Paleozoic basement, the first movements of the Alpine cycle occurred near the end of the Cretaceous period and correspond either with interruptions in deposition or with a neritic facies. The Pyrenean movements—Middle Eocene and Oligocene—correspond with the first important phase of diastrophism, which is characterized by the transgression of Neogene deposits over the levelled surface of the Pyrenean folds. During the Middle and Upper Miocene periods, after the deposition of the transgressive Vindobonian deposits, the Alpine movements gave to the mountain chain its present aspect. More recent movements, which occurred during the Pliocene and Quaternary periods, were not very intense.

In this mountain region, the dislocations nowhere show complications similar to those of the Alps: in general the tectonic structure is simple and is characterized by an anticlinal folding with many faults. The intensity of the folding is great, especially in the Rif and in the Tellian Atlas, whereas the Saharan Atlas and the Middle Atlas of Morocco

[1]E. Suess, *La face de la terre* (Trad. fr. Paris, 1897-1921).
P. Termier, "Les Problèmes de la géologie tectonique de la Mediterranée occidentale," *Rev. gen. d. Sci.*, T. 22 (1911).
R. Staub, "Über Gliederung und Deutung der Gebirge Marokkos," *Ecl. geol. Helv.*, 20 (1926).
A. Marin, M. Blumenthal, P. Fallot, "Observations géologiques sur le Rif Marocain," *Bull. Soc. géol. d. France*, T. 30 (1930).

show widely extended domal uplifts, where the beds do not ordinarily show a steep dip. The principal tectonic complication is due to the presence of Triassic deposits, which have been a very special factor and must be mentioned because of their importance with reference to petroleum researches, which are of principal interest in this discussion. Most of the Triassic deposits are formed by salt and gypsum marls with intercalations of dolomites and ophites, and, because of the well known plasticity of deposits of this kind, the Triassic formations have facilitated the sliding of the upper sedimentary series above the Hercynian substratum. Furthermore, the Triassic deposits took advantage of all the weak points so as to accumulate along the fracture lines, giving rise to diapir folds. On the surface, the core of these folds generally seems to have been formed by a chaotic accumulation of red clays and gypsum, which in fact is only the cap rock of deep salt masses. Besides, at several places in northern Africa there are salt mountains, probably a result of recent and continuous ascension of salt masses under the conditions of desert climate.[1]

The Triassic beds occur principally along anticlinal lines, particularly in the vicinity of plunging folds, but are known to exist also in synclinal areas. Their importance varies considerably and their width ranges from several meters to several kilometers.

MOROCCO

Active research in Morocco is limited to the southern part of the Rif.

The structure of this region is complicated. In general, this region corresponds with the limit of the Cretaceous-Oligocene Flysch zone with its Miocene foreland. Most of the Flysch zone is formed by an alternation of Nummulitic marls and sandstones, and in anticlinal areas it also includes Cretaceous deposits. This Flysch zone is folded into overlapping scales which show irregular structure and strike, and Triassic deposits can be observed in many places at the base.

The Miocene deposits of the foreland, which include Burdigalian sandstones, gray Vindobonian marls, and Sahelian sands, lie transgressively on the Flysch, which has been folded and eroded during the Eocene and Oligocene periods, but they have been affected themselves by the Upper Miocene movements, so that the transgression contact is at present very much dislocated. In some places a normal superposition of the Miocene deposits on the eroded folds of the Flysch can be observed,

[1]M. Gignoux, "La tectonique des terrains salifères et son rôle dans les Alpes françaises," *Livre Jubilaire Soc. géol. d. France* (1930).

FIG. 3.—"Klippen" of Liassic limestones piercing Cretaceous Flysch formations at Djebel Amerghou.

but in other places the contact plane is almost vertical or overturned. The Flysch zone nowhere covers the Miocene deposits throughout a large area, as a flat overthrust, as was thought several years ago. In places the Miocene-Flysch contact zone is marked by outcrops of saline Triassic deposits.

Toward the northwest, the Flysch folds show a tendency to plunge under the Miocene in the form of dislocated anticlines, the disposition of which is somewhat similar to that of the "spurs" of the Teleajen valley in Roumania.

In the Miocene zone itself, intensely folded anticlines show Triassic formations in their central parts, which are surrounded by remnants of generally very much flattened overlying formations: Cretaceous marls, Eocene limestones, et cetera. Some of these Triassic formations include entire blocks torn out from their substratum: syenites, mica-schists, et cetera. Jurassic limestones, which normally cover the Triassic deposits, occur only as separate blocks. In some places, this complex nucleus has not yet been sufficiently eroded, and only a Miocene dome appears on the surface with only Burdigalian or possibly Vindobonian outcrops in its center. Pliocene deposits form a cover of sands and pebbles lying transgressively over the aforementioned formations. This cover is slightly affected by small undulations.

North of Meknes, the conditions are different: large Jurassic anticlines rise above the Miocene plain; they belong to the border of the Morocco Meseta, which border has been influenced by tectonic movements the origin of which was in the Rif. This region is known as the Pre-Rif.

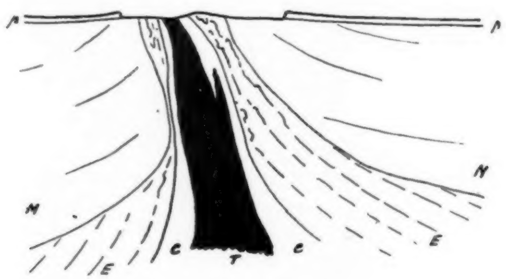

FIG. 4.—Typical anticline, showing Triassic diapir formation in Rharb region. *T*, Triassic. *C*, Cretaceous. *E*, Eocene. *M*, Miocene. *p*, Pliocene.

In the Rharb, several oil seepages are known, all of which are connected with diapir Triassic formations and are near the Miocene-Flysch contact zone. At the southwest, in the region of Ouergha River, oil seepages are scarce; however, several are known there in the Flysch zone near Triassic deposits. The easternmost petroleum seepages are those of Tizeroutine, which are found in the Miocene (?), in a zone of very complicated structure. At the northern end of one of the Pre-Rif anticlines (Jabal Tselfat), an interesting seepage has been observed in Upper Liassic deposits. In the last-named region, there are no Triassic outcrops and the anticline shows regular structure.

Thus, in the southern Rif, oil traces are not connected with a definite geological horizon, and they are found in the vicinity of dislocation lines in Triassic as well as in Liassic, Cretaceous, Nummulitic, and Miocene deposits.

Outside of the Rif, isolated seepages have been reported to exist in the southern part of the High Atlas, in the Agadir region, but their geological situation has not yet been studied.[1]

The petroleum indications of Rharb and of Tselfat have already been studied, but, as this research has been undertaken with insufficient financial means, it remains without result. Test drilling, begun in 1919, did not exceed a depth of 400 meters. It resulted in petroleum indications in the Miocene deposits of Rharb (Ain Hamra) and of Tselfat, where a small exploitation including 10 shallow wells functioned for several years. This was the principal success of this period.

Such was the situation when, in 1929, systematic researches were begun by two groups, the first including the National Office of Liquid Combustibles, the Compagnie Française des Pétroles, and the Bureau of Researches and Participations of Morocco; the second being the Belgian group Financo. In some areas, these groups worked separately; in others, jointly. A detailed geological study of all this region has been undertaken by the use of modern means—micropaleontology, shallow core drilling—and at the same time geophysical, gravimetrical and electrical researches contributed to trace gradually the tectonic structure. A series of exploratory wells are now being drilled.

The principal effort of prospecting is at present concentrated in the Rharb and the Tselfat areas. Most of the test wells are in the Souk-el-Arba region of the Rharb: some are in the Miocene zone (Ain Hamra); others are on the border zone of the Flysch (Sidi-bou-Mlid, Karia Jraïffi,

[1]Information kindly supplied by W. P. Haynes.

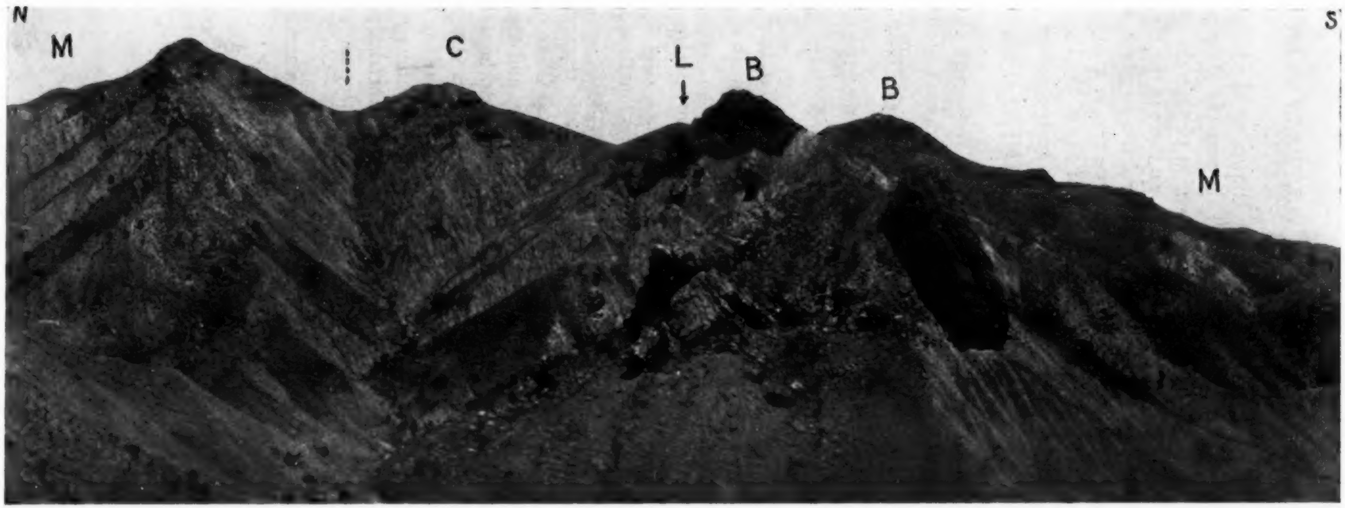

FIG. 5.—Tizeroutine. View of fold in this region. *M*, Miocene (perhaps Eocene ?). *C*, Cretaceous. *B*, Burdigalian sandstones. *L*, Liassic limestones (at bottom). View taken from east. Tizeroutine seepage in ravine at left.

Sidi Moussa ben Zered). In addition to the investigations already mentioned, only shallow wells for purely geological purposes have been drilled in the Tselfat. Two of these wells are at present producing 4,000 kilograms per day, but a deep well has recently been commenced. In the Fez region, a Miocene dome has been prospected, though without favorable result. In the Tizeroutine region, only geological studies have been made. Table I indicates the importance and the results of the work. The shallow wells have not been included in this table.

TABLE I

PRINCIPAL WELLS DRILLED IN MOROCCO

Region	*Date of Drilling*	*Final Depth in Meters*	*Remarks*
Outita	1921	263	
Tselfat	1919-1927	87-210	Traces and small production
Sidi Moussa ben Zered	1921	300	Traces of oil
	1927	275	
	1928	401	
	1930	510	Traces of oil
Sidi bou Mlid	1925	386	Traces of gas
Dahar Larbi	1923	221	
Karia Jraïffi	1930	1,109	Slight traces
Ain Hamra	1923	318	Traces and small production
	1929	484	Traces
	1930	576	Slight traces
	1931	1,380 (incomplete)	
Fez	1931	919	

Thus, in spite of considerable effort, nothing but interesting traces have been discovered in Morocco. It would be premature to formulate definite judgment about the future of this work, as the principal object was only to study certain "structures." The complicated tectonic structure and the very marly character of all the sedimentary series are the principal difficulties, which are increased by the similarity of the marls belonging to different formations, which makes the stratigraphic and tectonic interpretation a particularly delicate problem. Only a rational development of the research will indicate whether Morocco possesses industrially exploitable oil occurrences.

ALGERIA

The most important research undertaken in Algeria was concentrated in the Oran region, in a Miocene basin, which corresponds with

the valleys of the Chelif and of the Hillil, and which is located in the central part of the Tellian Atlas.

This region is bordered by the Dahra and Ouarsenis mountain zones, the origin of which is due to Pyrenean movements, and toward the south the Miocene deposits extend to the tabular zone of the highlands near Mascara. Thus, the transgression of the Miocene could not extend here over a large area and had to limit itself to filling the channels between the already folded massifs. Later, post-Sahelian, Alpine movements have intensely folded all this area and have determined the formation, in the Neogene basin, of faulted anticlines, the cores of some of which are formed by small masses of Triassic strata and by fragments of the Cretaceous and Eocene substratum.

Natural seepages appear either near these dislocations in Helvetian marls, as in the Tliouanet region, or along the lines of folding in the Sahelian deposits, as in the plain of Chelif.

The region of Tliouanet shows domal structure of the Helvetian marls, the substratum of which—chiefly Triassic and Cretaceous deposits—is exposed at several places.

In the Chelif plain, most of the outcrops are of Upper Miocene and Pliocene formations. The folds are intensely dislocated and faulted, but do not show their substratum. Oil indications appear along the line of deformation in the Pliocene deposits or in the upper part of the Sahelian, but generally near dislocations.

Among all the petroleum researches undertaken in northern Africa, those of Algeria are the oldest, but as they did not yield very favorable results, they were abandoned. A description of the details of these attempts can be found in the excellent work of Dalloni.

REGION OF TLIOUANET

The region of Tliouanet corresponds with the southern part of the Miocene basin.

The following description is an excellent summary prepared by Mena, who for several years has studied this region in detail.

The sedimentary series, of which the Tliouanet basin is composed, is the following.

1. A substratum of Cretaceous and Eocene beds showing overlapping recumbent folds. A complete sequence of Cretaceous formations is found here from the bottom to the Senonian period. In general, these Cretaceous deposits are formed by shaly marls, except the Cenomanian beds, which consist of fissile limestones of slight thickness. Eocene deposits are formed by

marls with reniform flints, above which are gray sandstones with ***Nummulites***. Their thickness seems to decrease from the south to the north.

Owing to the intensity of the folding, it is difficult to say whether there is an unconformity between the Cretaceous and the Eocene deposits. The thickness of this complex of recumbent folds, which are normally dipping at an angle of 45°, is not known, but nowhere have older formations been observed.

2. This substratum is covered by a sequence of formations belonging to various periods, ranging from the Helvetian up to the Upper Pliocene.

The thickness and the composition of these different horizons vary considerably from place to place: in general, they are composed of a more or less well developed recurrence of sandstones, marls, and gypsum or tripoli, but in a distance of only a few kilometers enormous variations in facies and thickness can be observed: thus, for instance in a distance of 30 kilometers the thickness of Sahelian deposits varies from a few meters to 1,200 meters; the same has been observed with regard to the Lower Pliocene; even the thickness of the Helvetian deposits varies from 20 meters at Mascara to 700 meters at Tliouanet.

These various Tertiary horizons are generally horizontal and conformable one above another. However, on the flanks of domes there are certain unconformities, more recent deposits dipping at a smaller angle than the older ones: this is the consequence of a continuous unconformity in an area which was progressively and continuously uplifted.

However, in the southern part of the basin, a series of intermediary horizons is intercalated between the Helvetian deposits and the Secondary substratum: these intermediary horizons belong either to the Oligocene period, represented essentially by continental Aquitanian deposits, or to the Lower Miocene period, known as the Cartennian. These deposits, which do not exist in the region of Tliouanet, lie unconformably on the Cretaceous-Eocene substratum, and are unconformably covered by Helvetian deposits, though the latter unconformity is less pronounced than the first.

All this region is crossed by rows of domes, outside of which the covering beds are horizontal. All these domes show the same structure: when the substratum appears on the surface, it always has the form of a horst with one fracture or several paralleling the strike of the dome. In these fractures dolomites, ophites, and multicolored marls are observed, generally known in northern Africa as Triassic formations. All wells drilled in these Triassic formations come into a salt-massif at shallow depth; in other words, this Triassic is nothing but a cap rock.

The covering beds mould themselves on the horst and take the form of a dome without any fracturing, with dissymmetrical flanks, the steep part of which corresponds with the outthrown part of the underlying horst, and the axis of which corresponds more or less with the fault.

Petroleum researches in Tliouanet were begun in 1898 because of seepages at the domes of Medgillah and M'sila. This first period of researches (1898-1901) yielded no favorable results and the drilling of a further series of test wells was begun in 1912.

The dome of Medgillah was first prospected in 1899, but only in 1918 was a small quantity of oil obtained from a depth of 70 meters.

Drilling was commenced on the dome of M'sila, several kilometers farther south, in 1898, but oil was not produced until 1914. Later, this work resulted in a small field.

Mena describes these occurrences as follows.

Petroleum is being produced at Tliouanet at the domes of M'sila and Medgillah; recent drilling at the El Bordj dome hitherto produced only gas.

In this region the Eocene-Cretaceous substratum (the Eocene being encountered only incidentally) is covered by Helvetian deposits at the bottom of which there is a horizon of very variable sandstones including conglomerates, polyp reefs and some limestones with *Lithothamnium*. The thickness of this sandstone horizon varies from 50 meters to a few meters and the decrease of the thickness is due either to stratigraphic or to tectonic conditions. Above are compact blue marls with few sandstone beds. The thickness of these marls must reach 700 meters. On the summits of the exploited domes the basal sandstone is found at a depth of 120-150 meters, the remainder having been eroded.

Hitherto, only Miocene beds have been exploited; oil is found here in the basic sandstones, which, outside of the domes, are normally water-bearing. During the last years the Cretaceous substratum also has been tested. All petroleum indications here have been found in connection with crushed zones at all the depths reached by the drill, but no important accumulation of oil has been encountered. However, it has been found that large quantities of gaseous salt water exist here at several places.

The petroleum occurrences are strictly localized and are found at the summits of the domes in Helvetian deposits or in the steep flanks in Cretaceous deposits.

The cross section (Fig. 6) shows the general location of the M'sila field, on the basis of an unpublished drawing of Mena. Tables II and III show the principal wells in Algeria and the quantities of crude oil produced since 1914.

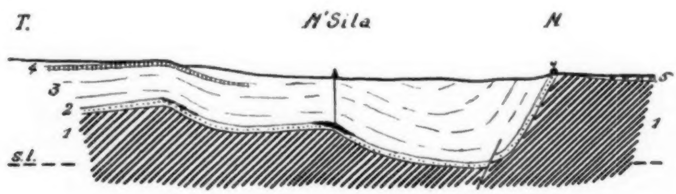

FIG. 6.—Cross section along Oued Tliouanet across M'sila works (according to sketch kindly supplied by Mena). 1, Cretaceous-Eocene. 2, Lower Miocene sandstones. 3, Miocene. 4, limestones with *Lithothamnium*. 5, alluvial formations. Height exaggerated. Length of section, 2.79 miles, or 4,500 meters.

TABLE II

PRINCIPAL WELLS IN ALGERIA

Region	*Date of Drilling*	*Final Depth in Meters*	*Geological Horizon Penetrated*	*Remarks*
Ain Zeft	1892	300	Sahelian	
	1892	215	Sahelian	
	1894	250	Sahelian	
	1894	450	Sahelian	Small production*
	1896	216	Sahelian	
	1897	359	Sahelian	
	1903	105	Sahelian	Some traces of oil
	1905	211	Sahelian	
	1912	1,114	Sahelian	
	1919	757	Sahelian	Deepening of an old well
	1919	1,223	Sahelian	Bottom of Oligocene (?)
Sidi Brahim	1896	290	Sahelian	Oil and gas traces
	to	322	Sahelian	Oil and gas traces
		360	Sahelian	Oil and gas traces
	1899	240	Sahelian	Oil and gas traces
Oued Tharia	1897	232	Upper Sahelian	Slight traces
	1898	270	Upper Sahelian	Slight traces
Mazouna	1895	74	(?)	Gas traces
	1895	164	(?)	Gas traces
	1895	308	(?)	Gas traces
	1895	301	(?)	Gas traces
	1915	1,075	Sahelian	
Rebelais	1919	1,364	Lower Sahelian	Traces
Bel Acel	1914	430	Pliocene-Upper Sahelian	Gas and water
	1921	542	Pliocene	
	1922	500	Pliocene-Upper Sahelian	Gas and water
Tahamda	1919	1,031	Sahelian	Slight traces
	1919	800	Pliocene	
Port aux Poules	1895	160	Sahelian	Gas
	1895	50	(?)	
	1895	100	(?)	Gas traces
	1895	272	Upper Sahelian	Gas (CO_2H_2S) and water

*See Table III.

CHELIF VALLEY

The Chelif valley extends 180 kilometers between the massifs of Dahra and of Ouarsenis, which are mostly formed by Cretaceous deposits. This area corresponds with the axial region of an old geanticline which divided the Tellian syncline.

Contrary to conditions in the preceding region, there are no outcrops of Helvetian formations in the Chelif region, and it even seems that

TABLE III

CRUDE OIL PRODUCTION IN ALGERIA

Year	*Metric Tons*	*Region*
1904	222	Ain Zeft
1905	205	Ain Zeft
1906	56	Ain Zeft
1907	135	Ain Zeft
1908	121	Ain Zeft
1909	120	Ain Zeft
1910	69	Ain Zeft
1911	120	Ain Zeft
1912	186	Ain Zeft
1913	67	Ain Zeft
1914	142	Ain Zeft and Tliouanet
1915	651	Tliouanet
1916	1,186	Tliouanet
1917	867	Tliouanet
1918	1,026	Tliouanet
1919	833	Tliouanet
1920	609	Tliouanet
1921	418	Tliouanet
1922	1,390	Tliouanet
1923	1,382	Tliouanet
1924	1,337	Tliouanet
1925	1,737	Tliouanet
1926	1,822	Tliouanet
1927	1,427	Tliouanet
1928	1,204	Tliouanet
1929	3,048	Tliouanet
1930	1,653	Tliouanet
1931	1,200	Tliouanet

these formations have not been reached in the test wells, the Sahelian and the Pliocene being the only horizons which have been penetrated.

The old work was concentrated in the vicinity of natural seepages, but several recent tests were located on structural considerations. Table II shows that these tests can be divided into several groups, as follows. 1. Some tests were located on visible structure in Pliocene formations. They did not reach the bottom of these formations and did not encounter any petroleum indications. 2. Several tests penetrated into the Sahelian horizons, and in the Upper Sahelian sands they encountered strong water flows with gas eruptions. 3. Some tests, particularly at Ain-Zeft, encountered oil indications in the Sahelian horizons, but nowhere was oil regularly produced and no commercially exploitable oil field could be created.

It is certain that many of the old attempts were hazardous and, except near natural seepages, were not based on any scientific plan. It should also be stated that the systematic prospecting undertaken in the last place by the Pearson group in 1919 did not result in success, though many seemingly favorable structural areas were drilled by relatively

deep wells. It is also remarkable that none of these test wells seems to have reached the Tortonian sands and the Helvetian deposits, from which a small quantity of oil is obtained at Tliouanet.

Outside of the Oran region, no test wells were drilled in the other parts of Algeria. However, surface indications are known to exist at several other places in Algeria.

In many places paralleling the Tellian Atlas, bituminous indications have been reported, a description of which may be found in the work of Dalloni previously mentioned. Most of these indications are bituminous shale or bituminous limestone with traces of bitumen in the fissures, and they do not seem to be of special importance. However, at several places somewhat more important bituminous deposits are known, which some time ago were considered as lignite beds (Fedj Mzala, Constantine), and in one place they have been prospected by means of galleries (St. Arnaud). Most of these bitumens are found in Eocene limestones (St. Arnaud), in the Senonian deposits (Fedj Mzala), and in the Triassic (Ch. el Kraten). Some of these occurrences are theoretically interesting; for example, the bituminous indications in phosphate limestones, which occur at the bottom of Eocene deposits and are exploited in several parts of northern Algeria.[1] In some places these phosphates are bituminous and in places real seepages of a very viscous oil have been observed either in the galleries of mines, or at the surface (Tocqueville, Rdir).

A few oil seepages are also known at several places in the Tellian Atlas. At Renier, an oil seepage accompanied by gas emanations has been observed near a fault which brings into contact Miocene and Eocene formations, and at Sidi Aissa another seepage has been reported to exist in Eocene formations near a contact with a Triassic diapir core.

In summary, it may be stated that, with the exception of the environs of Oran, all indications of hydrocarbons in the Tellian Atlas of Algeria are unimportant. They occur in the vicinity of Triassic formations, which in Algeria, as well as in Morocco, seem to have facilitated the migration of the bitumens because of their diapir structure.

The Saharan Atlas seems to be almost barren of petroleum indications. At several places, however, bituminous traces have been reported to exist in limestones, and petroleum indications are said to have been found in an artesian water well, but these do not seem to offer any practical interest.

[1]The same horizons are exploited on a large scale in southern Tunisia and in the adjacent parts of Algeria. The Morocco phosphates belong to somewhat older horizons.

No serious research work has ever been undertaken in the vicinity of hydrocarbon indications in Algeria, except in the Oran region.

TUNISIA

The geological structure of Tunisia is characterized by the joining of the folds of the Tellian Atlas of Algeria and those of the Saharan Atlas, as a consequence of the disappearance of the tabular zone of the highlands.

The folds strike northeast and are grouped in northern Tunisia into several zones.[1]

1. The Flysch zone, which is an extension of the northern branch of the Tellian Atlas of Algeria, is characterized by a considerable development of the Eocene-Oligocene Flysch and is folded into a system of long, overlapping, faulted folds.
2. The zone of isoclinal folds is composed mainly of Cretaceous and Eocene formations, although Triassic diapir masses are very important in this region, forming the core of the folds.
3. The axis zone of the Tunisian chains, or Dorsale Tunisienne, forms large domes with Jurassic cores and is a continuation of the Saharan Atlas.

In Algeria most of the petroleum indications are found in the Tellian Atlas, whereas they are almost completely lacking in the Saharan Atlas. Therefore, it is not surprising to note that the only petroleum indications which have hitherto been discovered in Tunisia are in the northern part of this country and that all research work has been limited to this northern region. These petroleum indications are not plentiful. In fact, the writer has seen only one important seepage at Kef bou Debbous. It is in the central part of a Cretaceous anticline in Cenomanian formations at the extremity of an important Triassic diapir massif. This seepage has not been tested by means of drilling.

At a distance of 20 kilometers farther east, an outcrop of bituminous sandstone of the Miocene period is known to exist at Sloughia and here

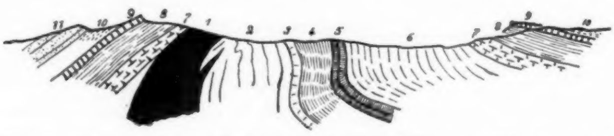

FIG. 7.—Cross section of Kef bou Debbous anticline. 1, Triassic. 2, Aptian. 3, 4, Cenomanian. 5, 6, 7, Upper Cretaceous. 8, 9, Lower Eocene. 10, Middle Eocene. 11, Upper Eocene. Length of section, 2.6 miles or 4,200 meters.

[1] M. Solignac, *Étude géologique de la Tunisie septentrionale* (Tunis, 1927).

FIG. 8.—Panoramic view of Kef bou Debbous anticline.

also it is at the extremity of an important massif of gypsiferous and saliferous Triassic deposits (Jabal ed Djebs). Although not very important, this petroleum indication has been tested by several drillings, which are summarized in Table IV.

TABLE IV

PRINCIPAL WELLS IN TUNISIA

Region	*Date of Drilling*	*Final Depth in Meters*	*Geological Horizons Drilled Through*	*Remarks*
Sloughia	1911	160	Miocene	Strong traces at 55, 74, and 127 meters
	1920	204	Tortonian, Helvetian	Oil traces
	1921	206		Deepening of first well; traces
Ain Rhelal	1909	73	Tortonian	Slight traces
	1920	800	Helvetian	No traces
Cap Bon	1924	1,540	Lower Eocene and Cretaceous	Slight traces

Thus, four shallow wells did not yield any results excepting to prove the existence of petroleum traces in the Helvetian deposits. This work will be resumed in 1932 on a well defined structure in Miocene deposits south of this place.

On the continuation of the preceding zone, oil indications have been reported to exist at Ain Rhelal, at a distance of 25 kilometers south of Bizerta. These indications can not be observed any more at present, though two wells have been drilled in this region. Here also there is a Miocene dome, the flanks of which show a sequence of Helvetian, Tortonian, and Sahelian deposits covered by Pliocene formations. The central part of this dome is pierced by a Triassic massif which is probably similar to a salt massif at depth, which has caused the formation of a klippe[1] of Eocene limestone on the flank of the dome. The first well, drilled in 1909, reached a depth of 79 meters and encountered some petroleum indications in the Tortonian deposits. A second well, drilled in 1920, reached a depth of 806 meters, but remained in steeply dipping Helvetian deposits and did not disclose any oil indications.

In Tunisia, as in Algeria, the existence of other less important indications has been reported; almost all of them consist of bituminous traces in Cretaceous or Nummulitic limestones; an asphaltite lentil has

[1]Large block piercing the covering beds.

been found in Triassic deposits (Jabal bou Diss). A shallow well at Medjez el Bab was drilled because of indications supplied by a source-finder.

The last attempt in Tunisia, in 1924, was made by the Standard Franco-Americaine, after completing very interesting work in the peninsula of Cap Bon, east of Tunis. This region is the continuation of the Dorsale Tunisienne and corresponds, tectonically, with a much more southern zone than that of Teboursouk. This region is characterized by the presence of domes which are Jurassic in its southern part, and Eocene near Cap Bon, because of a general plunge of the formations in this direction. The tectonic conditions here are entirely different from those in the Teboursouk region, and no Triassic diapir extrusions are found here in the cores of the folds.

The well at Cap Bon was located on the center of a very regular dome which shows outcrops of Middle Eocene deposits; it penetrated Lower Eocene limestones, and passed through Cretaceous deposits consisting mostly of marls at its final depth of 1,564 meters. This well encountered only unimportant traces of oil.

CONCLUSIONS

The data recorded in the preceding pages show that, with the exception of the small fields of Tliouanet and Jabal Tselfat, the production of which, as already mentioned, is almost insignificant, all drilling tests in northern Africa were failures.

Many of these failures are due to unsatisfactory working methods, too shallow drilling, and insufficient preliminary geological studies. Other failures resulted from the difficulties of the problem itself, as the complexity of the diapir structure with Triassic nuclei, the marly character of the greater part of the geological horizons, the absence of porous beds, and the distribution of the surface petroleum showings so that it is very difficult to connect them with outcrops of a formation belonging to a definite period, or with definite tectonic structure.

Therefore it would require delicate discrimination to formulate an opinion about the chances of success of the researches which are at present being carried on in Morocco and which will be undertaken in the near future in Tunisia. As they are based on very detailed and thorough geological studies, whatever their final issue may be, they will have been of value, as they will give a definite solution to the petroleum problem of northern Africa, which has been awaited many years.

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OVERHANGING CAP ROCK AND SALT AT BARBERS HILL, CHAMBERS COUNTY, TEXAS[1]

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ABSTRACT

Overhanging cap rock and salt were discovered on this dome in January, 1930, when a well on encountering salt was drilled deeper through more than 800 feet of salt into the sedimentary beds below. Up to the present, fifty-two wells have been drilled through the cap rock and salt. The greatest thickness of salt penetrated was 2,419 feet.

The overhang is shallowest on the north, east, and south flanks, where drilling has shown that it projects outward distances ranging from 400 feet to 1,300 feet. The projection of the cap rock and salt on the west flank lies much deeper below the surface and has had very little exploration.

The movement producing the overhang seems to have disturbed only slightly the prolific oil sands of the Miocene and Oligocene ages lying below it.

Three general theories of the origin of salt-dome overhangs are given: upward and outward movement of the salt; downbuilding of salt domes; and solution of salt on the flanks. The writers believe that the first of these was the main cause of the overhang at Barbers Hill, and that the third was a lesser contributing factor.

The discovery of the overhang has uncovered reserves of oil sufficiently large to establish Barbers Hill as one of the major producing domes of the Gulf Coast.

INTRODUCTION

Barbers Hill salt dome is 27 miles east of Houston in the Gulf Coast region of Texas. On this dome, masses of the top of the salt with its overlying cap rock project well beyond the outer limits of the main salt plug and form an "overhang." Beneath this a series of prolific oil sands are now being intensively developed. Drilling has proved this condition to exist on all flanks except the southwest, where additional exploration is necessary to confirm the presence of the overhang. A few small ledges of cap rock and an occurrence or two of probable overhanging salt on one flank have been found previously on other salt domes in this region, but no extensive ledge of overhanging salt similar to that found at Barbers Hill has been outlined by drilling.

[1]Presented before the Association at the San Antonio meeting, March 19, 1931 Manuscript received, February 27, 1932.

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The early exploration of this dome was described by Bevier,[1] and the later development of the deep flank sands was described by Murphy and Judson.[2]

ACKNOWLEDGMENTS

Field data furnished by the Humphreys Corporation, Texas Gulf Producing Company, and many of the other companies operating at Barbers Hill have been of much aid in the preparation of this paper.

Much of the theory of the formation of overhanging cap rock has been suggested by other Gulf Coast students. The section on the theory of overhang caused by the downbuilding of salt domes is contributed in its entirety by Donald C. Barton. The section on the theory of the solution of salt on flanks of domes by circulating waters is furnished by Marcus A. Hanna.

DISCOVERY AND EXPLORATION OF OVERHANG

Cap-rock overhang.—The first suggestion of the overhang at Barbers Hill came from P. T. Seashore's observation that in several wells on the northeast flank, the dips in beds at depths ranging from 3,000 to 4,100 feet were gentler than in those at depths between 2,100 and 2,200 feet. As the normal dip is steepest nearest the dome, this decrease of dip with depth showed that the well was nearer the dome at the higher level and indicated that an overhang of cap rock was present. Therefore, in 1927, on recommendation of their geological department, the Humphreys Corporation drilled Kirby No. B-5, 150 feet closer to the dome than previous deep wells. This test penetrated 30 feet of massive anhydrite cap rock, porous in places, from 2,193 to 2,223 feet, and went again into sedimentary beds below. This well was abandoned at 4,929 feet on account of the sticking of the drill stem, and no further drilling through cap rock occurred until 1929, when, in order to reach the 5,200-foot sand high on the structure, several wells were drilled through this cap-rock overhang and prolific yield was for the first time obtained beneath.

Salt overhang.—The presence of the salt overhang was first established in January, 1930, when the Humphreys Corporation, after finding salt beneath the cap rock at 1,531 feet in their Ilfrey No. 2 on the east flank, instead of abandoning the well, drilled through 878 feet of salt on the advice of the two senior writers of this paper, and reached sedimentary

[1] G. M. Bevier, "The Barbers Hill Oil Field, Chambers County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 9, No. 6 (September, 1925), p. 958.

[2] P. C. Murphy and S. A. Judson, "Deep-Sand Development at Barbers Hill, Chambers County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 11, No. 6 (June, 1930), p. 719.

beds beneath. This was completed as a flowing well in the 5,100-foot sand and soon led to the general practice of drilling through the salt overhang. Up to the present, fifty-two such wells have been completed, and have produced prolifically on all flanks extensively drilled. These wells are distributed as follows: north flank, 14 wells; east flank, 23; south flank, 13; and west flank, 2; total, 52 wells.

The greatest thickness of overhanging salt found to date was in the Texas Gulf Producing Company's Morgan-Fitzgerald No. 1 on the northeast flank, which penetrated salt from 1,376 to 3,795 feet, a thickness of 2,419 feet. At present, January, 1932, the thirteen wells drilling at Barbers Hill are so located that they have either been drilled through the salt overhang or are expected to penetrate it.

A table of wells which have been drilled through overhanging salt with wells arranged in approximately chronological order is shown in Table I.

EXTENT AND SHAPE OF OVERHANG

Dome divided into two segments based on depth of overhang.—The periphery of the dome is divided into two segments according to depth of overhang in the wells. These segments are separated by transition zones *C* and *C′* indicated on the key map in Figure 1. The eastern segment, embracing five-eighths of the periphery of the dome, has the shallower overhang. The part of this which projects farthest outward from the dome has a nearly uniform depth of approximately 2,500 feet. The overhang of the western segment has its maximum projection ranging in depth from 4,000 to 4,875 feet in the two wells which have been drilled through the salt on this flank. The northern transition zone *C* has been partly explored and consists of an overhanging ledge of cap rock and salt which connects the deeper overhang of the western segment with the shallower overhang of the eastern segment. The transition zone *C′* on the south theoretically exists but has not been proved by drilling.

The cap-rock overhang projects outward well beyond the salt overhang excepting at the position of the transition zones and on the southern part of the dome. This added projection reaches a maximum of 450 feet on the north and east flanks. These outer limits of the salt and cap rock are outlined in Figure 2.

The cap-rock overhang has been proved by drilling to extend outward on the northeast flank from the main salt stock at least 1,300 feet. Lack of information caused by the absence of deep wells near the main

TABLE I

WELLS DRILLED THROUGH OVERHANG SALT—BARBERS HILL DOME—CHAMBERS CO., TEXAS

	OPERATOR	LEASE	SALT		TOTAL SALT	T D	COMPLETED	INITIAL PRODUCTION	REMARKS	FLANK
			TOP	BOTTOM						
1	Humphreys Corp. *	Ilfreys #2	1531	2409	878	5087	2-26-30	1062		East
2	" " *	McLean #1	2066	2293	227	5360	3-22-30	1150	Drilled to 6078'-Plugged back to 5360'	"
3	" "	Morgan #1	2346	2542	196	6404	6-26-30	319	Later deepened to 6469 and abandoned	N.E.
4	" " *	Kirby C-2	2196	2245	49	5224	6-29-30	20	Small pumper	East
5	Mills Bennett Prod Co	Gulf-Fisher #2	2177	2433	256	4710	7-12-30	1852	Later deepened and completed at 5242'	South
6	Sun Oil Co	Chambers #5	2223	2573	350	4124	8-22-30	1000	Later deepened and completed at 4622'	"
7	" " "	Wilburn Fee #9	2091	2101	10	5167	9-19-30	126		S.E.
8	Mills Bennett Prod Co	E. W. Barber #3	1557	3198	1641	5147	10-1-30	1450		North
9	Humphreys Corp. *	T.S Fitzgerald #1	2115	2664	549	5567	10-19-30	1500		N.E.
10	Yount Lee Oil Co	Chambers #16	2338	2486	148	4133	11-25-30	1320	Later deepened and completed at 5255'	South
11	Humphreys Corp. *	Kirby B-8	1631	2551	920	5295	11-29-30	1920		East
12	" " *	Barber A-6	3581	4360	779	5485	12-16-30	982		N.W.
13	Sun Oil Co	Wilburn Fee #12	2045	2325	280	5127	12-18-30	580		S.E.
14	Humphreys Corp. *	E.W. Barber B-1	2085	2721	636	6795	12-26-30	None	Stuck drill pipe - Abandoned	N.E.
15	Sun Oil Co	Chambers #7	1836	3092	1256	4583	1-10-31	2013		South
16	Mills Bennett Prod Co	Gulf-Fisher #3	1467	2792	1325	4437	1-22-31	1336		"
17	Yount Lee Oil Co	Chambers #17	1453	3341	1888	5054	2-9-31	180		"
18	Humphreys Corp. *	Kirby A-10	3120	3346	226	6955	2-20-31	None	Tested Salt Water at 6378'—Abandoned at 6955	N.W.
19	" " *	L. E. Fitzgerald #1	1424	3242	1821	5379			Top 2nd Salt 4928-T.D.5379 Salt-Sidetracked 1100	N.E.
19	" " *	" " " "	1424	2963	1539	5199	3-16-31 •	1977		"
20	Yount Lee Oil Co	Chambers #18	1758	3383	1625	4465	3-24-31	690		South
21	Mills Bennett Prod Co	E. W. Barber B-1	1415	3112	1697	5320	3-25-31	225		North
22	Sun Oil Co	Chambers #8	1833	3188	1355	4521	4-6-31	1100		South
23	Humphreys Corp *	Barber B-2	1389	3239	1850	5079	4-11-31	1852		N.E.
24	" " *	J. F. Wilburn #2	1715	2007	292	5234	4-24-31	1115		S.E.
25	Yount Lee Oil Co	Chambers #19	1870		3821	5691			5691 T.D in Salt-Plugged back to 1800' Sidetracked	S.
"	" " " "	" "	1765	3693	1928	3794	4-30-31	705		South
26	Sun Oil Co	Wilburn Fee #14	1527	2620	1093	3914	4-30-31	None	Stuck drill pipe - Abandoned	S.E.
27	Humphreys Corp *	Anna Davis #1	1422	2984	1562	5323	6-6-31	1901		N.E.
28	" " *	T.S Fitzgerald #2	1403	2940	1337	5259	6-23-31	1650		N.E.
29	Mills Bennett Prod. Co	Gulf-Fisher #4	1521	2903	1382	3044	6-27-31	1728		South
30	Humphreys Corp *	Fitzgerald-Meadows #1	1397	3361	1964	4232	7-29-31	1570		N.E.
31	Texas Co	J. F. Wilburn #6	1595	2368	773	4509	8-6-31	3746		East
32	Sun Oil Co	Annie Higgins #1	2170	2234	64	5341	9-7-31	250		South
33	Gulf Prod. Co	J. F. Wilburn #5	1674	2387	713	4494	10-4-31	1700		East
34	McAlbert Oil Co	J. F. Wilburn #4	1490	2420	930	4475	10-4-31	2000		"
35	Texas Gulf Prod. Co.	Eberspacher #1	1383	2830	1447	5313	10-10-31	1648		N.E.
36	Sun Oil Co	J. F. Wilburn #11	1499	2459	960	2610	10-23-31	200	Flowing by heads – 25 Gravity Oil	East
37	Mills Bennett Prod. Co.	J. F. Wilburn #5	1440	2856	1460	4407	10-24-31	3200		"
38	Sun Oil Co	D. K. Winfree #2	4661	4979	318	5359	10-28-31		Pumper - Later deepened and completed at 5637'	West
39	Texas Gulf Prod Co	Kirby H-8	1444	2338	894	4401	11-3-31	1908		East
40	Sinclair O. & G.	J. F. Wilburn #8	1430	2721	1291	4494	11-7-31	1400		"
41	Texas Gulf Prod. Co.	Tarbutton #2	1417	2634	1217	3506	11-15-31	712	Flowing by heads	"
42	Texas Co	J. F. Wilburn #7	1517	2376	859	4422	11-21-31	650		"
43	Texas Gulf Prod. Co.	Barber B-3	1381	3605	2224	4868	12-1-31	1494		N.E.
44	Texas Co	Lawrence Fee #2	1422	2667	1245	4425	12-2-31	90	Flow by heads - Later deepened to 5313'	East
45	Mills Bennett Prod. Co.	Gulf Fee #1	1365	3506	2141	5134	12-16-31	1320		N.E.
46	Gulf Prod. Co.	J. F. Wilburn #6	1426	2712	1286	4471	12-17-31	960		East
47	Texas Gulf Prod. Co	Morgan-Fitzgerald #1	1376	3795	2419	5214	1-3-32	2189		N.E.
48	Sun Oil Co	J. F. Wilburn #12	1496	2518	1022	4472	1-8-32	1200		East
49	Mills Bennett Prod Co	J. F. Wilburn #6	1406	2933	1527	5034	1-13-32	1922		"
50	" " " "	Gulf-Fisher #5	1480	3043	1563	4407	1-18-32	2100		South
51	Texas Gulf Prod Co	J. M. Fitzgerald #1	1409	3319	1910	5263	1-19-32	2200		N.E.
52	Sun Oil Co	Annie Higgins #2	1424	3549	2125	3648	1-27-32	1600		South

* Now Texas Gulf Producing Co.

salt prevents an accurate estimate of the width of the overhang on other flanks.

COMPOSITION OF OVERHANG

Cap rock.—The cap rock in the overhang has essentially the same character as the cap rock of the main part of the dome and consists, at

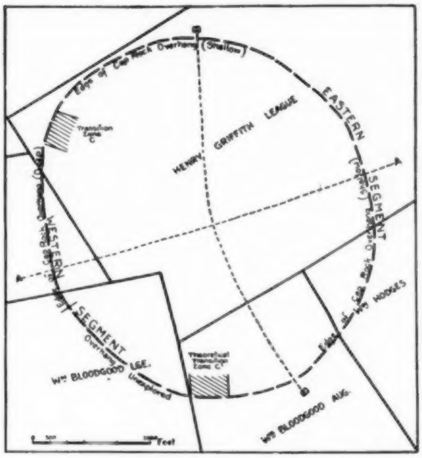

FIG. 1

the top, of secondary impure calcitic limestone. Beneath this there is ordinarily a short section of gypsum which grades downward to a nearly pure massive anhydrite, which constitutes the larger part of the total cap rock.

Salt.—The salt in the overhang is typical of the rock salt found in the central mass of the average salt dome of this region. Cores taken in it show an ordinary amount of impurities, mostly in the form of anhydrite crystals. The fact that the salt which is nearest the outside edge is hardest to drill suggests an increasing amount of impurities there.

Gouge zone.—The separation of the salt from the underlying sedimentary formations is not sharp, but consists of a gouge zone containing much secondary mineralization. The common presence of "anhydrite sand" with a maximum thickness of approximately 25 feet is particularly noteworthy, as this "anhydrite sand" is probably the residue left by the salt going into solution.

GENERAL SHAPE OF OVERHANG

The upper part of the dome has the shape popularly known as the "mushroom" type. The details of the several flanks are illustrated in cross sections in Figure 3 and Figure 4.

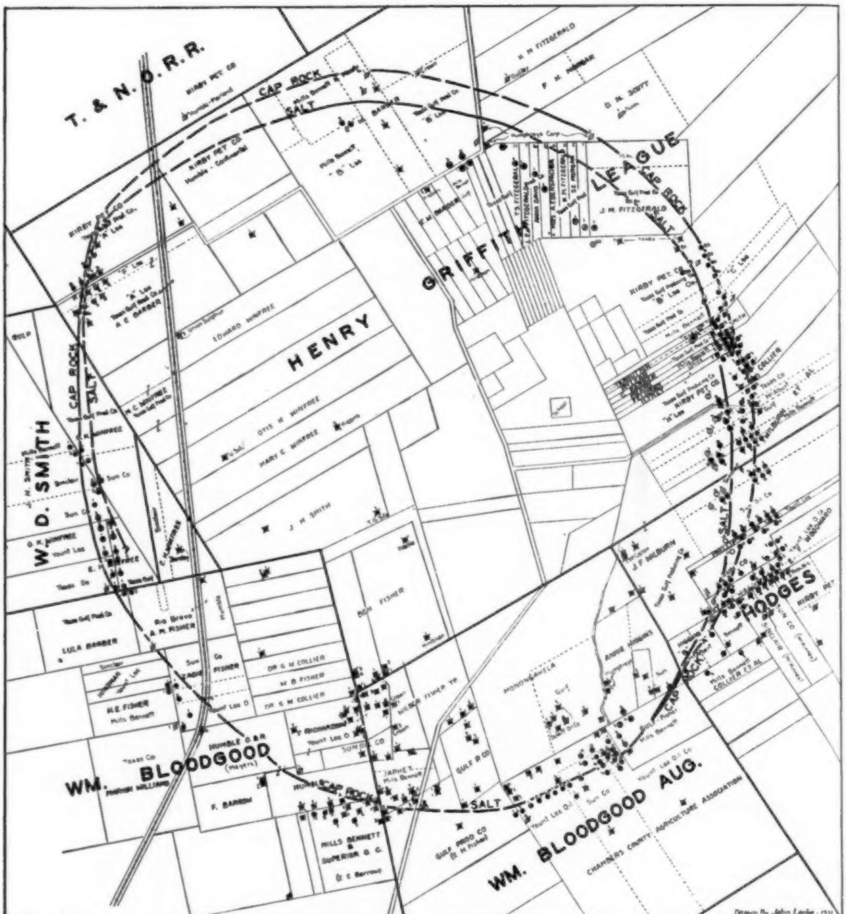

FIGURE 2.–BARBERS HILL SALT DOME
CHAMBERS CO., TEXAS
MAP SHOWING OUTER LIMITS OF CAP ROCK & SALT
SCALE IN FEET

LEGEND

FIG. 2

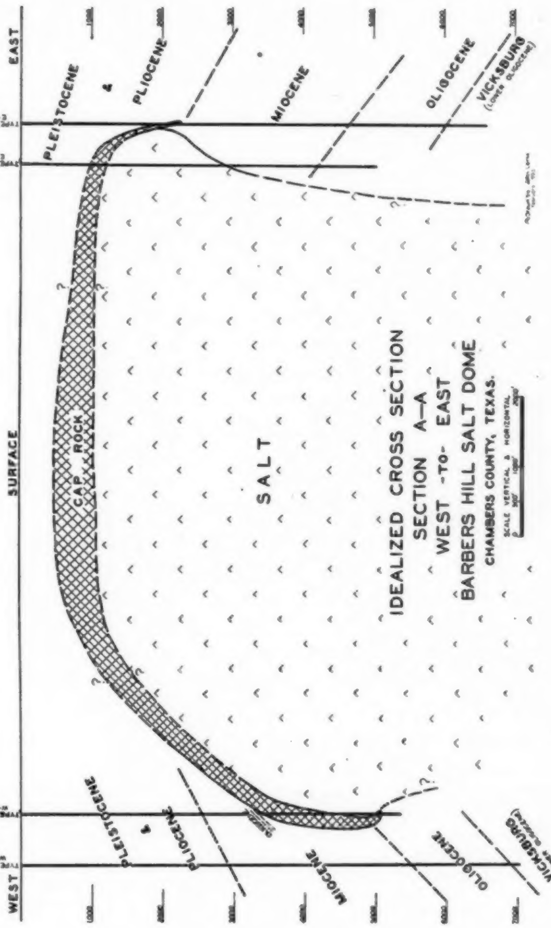

FIG. 3

The lower side of the overhanging salt slopes gradually inward toward the center of the dome. Whether the salt stock continues to slope inward below 4,000 or 5,000 feet is not known, as the deepest point at which wells have gone through the base of the salt overhang is 4,946 feet on the west flank and 3,795 feet on the northeast flank. However, there is

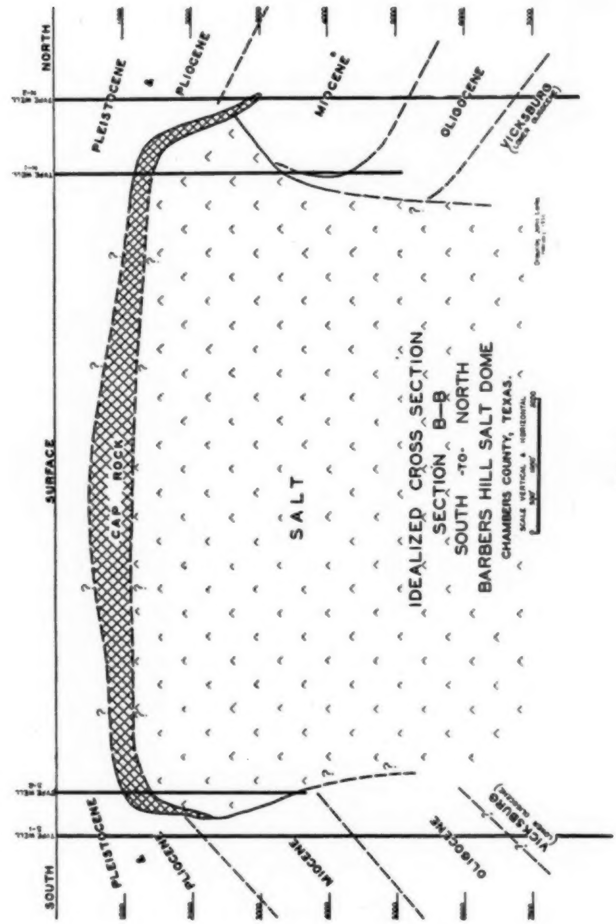

FIG. 4

a strong indication that the salt does not flare outward, that is, that it does not increase in its horizontal diameter, at or immediately below these depths, as tests on all flanks, ranging in depth from 6,617 feet on the east to 8,184 feet on the south, did not encounter salt or conditions which could be interpreted as indicating proximity to the salt plug. Type wells in-

dicating these conditions are shown in the cross sections of Figure 3 and Figure 4.

EFFECT OF OVERHANG ON SURROUNDING SEDIMENTARY FORMATIONS

Overlying formations.—It is not evident whether the overlying formations have been greatly affected by the movement producing the overhang, because of the scanty information yielded by the wells drilled. The beds have the secondary mineralization and increasing dip with added depth that is ordinarily expected above the cap rock on the flanks of a salt dome, but no special irregularity has been noticed except in one place, and that could only very doubtfully be attributed to movements of the overhang. This occurrence extends at least ½ mile along the west flank and consists of *Heterostegina* limestone and associated shales of Oligocene age which lie close to the cap rock 1,500 feet above their normal position and are surrounded by beds of Miocene age. These strata may have been separated from the remainder of the main Oligocene beds during their subsidence, by contact with the sloping cap rock.

Underlying formations.—The beds immediately under the gouge zone of the overhang should, of course, be most affected, but these seem no more disturbed and broken than if they were located a similar distance from the outward slope of a normal salt dome. Beneath the overhang, the sands and shales of Miocene age are ordinarily first encountered. Oil-producing sands are found in some places close to the gouge zone, indicating that though these sands may be sharply tilted, they exist in a body sufficiently continuous or connected to produce oil. However, it is noticeable in the eastern segment that the Miocene shales for the first 300 or 400 feet under the salt seem to be exceptionally soft.

The lower Miocene and the Oligocene beds penetrated seem to be practically unaffected by the movement producing the overhang excepting in one area where wells have been drilled close to the salt mass. These wells are on the northeast flank in the vicinity of the Texas Gulf Producing Company's E. W. Barber B-3. The conditions found there are illustrated in the north end of section *BB* in Figure 4. Here the Oligocene beds are overturned and are the first beds penetrated by the drill under the salt. Next, several hundred feet of Miocene is found and finally the formations of Oligocene age in a normal position are re-entered. This possibly represents a general condition existing close to the salt on all flanks, but much additional drilling will be required to determine this. The fact, however, that the volume of dry gas found immediately under the overhanging salt in the aforementioned wells was exception-

ally great, leads to the conclusion that this overturned condition of the strata close to the dome may be the exception rather than the rule.

EFFECT OF OVERHANG ON OIL AND GAS

Oil accumulation.—The overhang seems to have had a favorable influence on the accumulation of oil in consideration of the fact that where the upper ends of the Miocene and Oligocene sands project up under the overhang, these sands are more prolific than on the flanks, where they end against the cap rock above the overhang. The reason for this may be that the upper ends of the sands beneath the overhang are more completely sealed against the upward migration and escape of oil and gas, because of the absence of continuous porous cap rock such as is present in many places in the outer sheath of the dome above the overhang.

Withdrawal of oil.—The overhang undoubtedly retarded for many years the discovery and development of the prolific lower Miocene and Oligocene sands, because the few deep wells here and there had been drilled just off the edge of the known cap rock and accordingly had reached the sands so far down-dip that either small wells or dry holes resulted.

Most operators were reluctant to attempt to drill through the overhang even after the discovery of oil beneath the salt overhang on the east flank, because early drilling through cap rock and salt offered many hazards. Of these, the most discouraging feature was the fact that many of the early holes in the salt were so crooked that the operator was not sure that a well would reach the sand in a favorable position; if not, it might be dry. Another retarding influence was psychological, in that experience in the Gulf Coast for the past 30 years had taught operators and drillers alike to believe that when a well penetrated salt, hope for oil beneath was useless. However, the prolific nature of several wells beneath overhang salt soon led to the conviction that the overhang must be penetrated in order to reach the main part of the oil reserves. Operators improved their drilling methods until they were able to drill through the overhang nearly as quickly and safely as through the sedimentary formations. Accordingly, the general effect has been to retard for several years the time of the discovery and withdrawal of the oil from this dome. Because of improvement in straight-hole drilling methods and more positive identification of sand bodies, the amount of oil recovered will be greater than if the deep oil had been discovered at an earlier date.

GENERAL THEORIES CONCERNING CAUSE OF OVERHANGING CAP ROCK AND SALT ON DOMES OF GULF COAST

The processes and movements that cause overhangs have been a subject of much difference of opinion among Gulf Coast salt-dome students. The theories that are principally advanced at the present time follow.

UPWARD AND OUTWARD MOVEMENT OF SALT INTRUSION

Inverted cone type.—It is assumed that in many areas the deeply buried original salt bed was covered by thick competent strata. Under such conditions, when the salt was forced upward it broke through an opening in this cover which was much smaller than the top of the ultimate dome. As the plug ascended into progressively less consolidated sediments the diminishing lateral pressure allowed it to expand and thus caused the salt dome to have an overhang shaped like an inverted cone. Some strength is given to this theory by the fact that Cretaceous limestones of considerable thickness are found within 150 miles on the north and west, where the deeply buried formations of the Gulf Coast rise toward their outcrops. This suggests that these beds may be present at great depths in the Gulf Coast.

The experiments by Link[1] relating to salt-dome structures and the discussions accompanying them are of interest, as they are suggestive that a dome ascending under these conditions might have this shape.

Mushroom type.—Wherever an intruding salt mass is covered by a thick and heavy cap rock and surrounded by light unconsolidated strata close to the surface, further upward movement of the salt will be resisted by this weight, the upward moving salt will tend to be diverted in a lateral direction, and an overhang will be formed. When sufficient resistance has been built up on the flank, it will resume its upward movement.

When this lateral action occurs below the critical depth for salt plasticity, the salt moves outward in a plastic mass. However, should the salt movement occur sufficiently near the surface for the salt to have lost its plasticity, a mass of salt and cap rock would be broken from the main body and tilted outward as the main mass of salt continues to move upward. The overhang formed by resistance of the heavy cap rock diverting laterally an upward moving mass of salt, whether the action was above or below the critical depth, tends to project outward more abruptly than the movement described under the previous head-

[1]Theodore A. Link, "Experiments Relating to Salt-Dome Structures," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 14, No. 4 (April, 1930), p. 483.

ing, and takes a form that is more properly called the "mushroom" type of overhang.

OVERHANG CAUSED BY DOWNBUILDING OF SALT DOMES

The theory of the formation of salt domes by downbuilding has been advanced by Barton[1] and is briefly as follows.

The theory of downbuilding predicates that under certain conditions, (1) the main mass of the salt core tends to remain fixed in earth space and therefore at a constant depth below the surface if the surface remains at a constant level, and (2) that the base of the salt core builds downward by flowage of salt in under the base of the salt core. For the downbuilding to take place, the basement of the mother salt formation must be subsiding and the salt must be buoyant, that is, the salt core taken as a whole must be lighter than the surrounding sediments. The salt core on account of its buoyancy tends not to sink as the sediments subside with the subsidence of the basement. One might say, therefore, that there is incipient tendency for a vacuum under the foot of

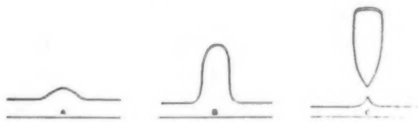

FIG. 5

the salt core. Salt flows horizontally in from the mother salt bed and diagonally downward from the flanks of the dome to fill the space of the incipient vacuum.

The form of the salt core should evolve through the series of forms shown in Figure 5. The final form should be that of an inverted elongate tear drop. Strictly its flanks overhang, but most of the overhang should come at very great depth, presumably below modern drilling depths. Although the overhang at Barbers Hill can not be the overhang of that inverted tear drop (Fig. 5-C), overhang of the Barbers Hill type should develop more readily on domes of type *C* rather than on the flaring domes of type *B*. It is interesting to notice that the torsion balance suggests that Barbers Hill approaches type *C* more closely than it does type *B*.

The tear-drop salt dome need not be formed solely in the downbuilding method of formation of salt domes, but might be formed in the upthrust method, if the buoyancy of the salt were sufficient.

SOLUTION OF SALT ON FLANKS OF DOMES BY CIRCULATING WATERS

The general theory of solution of salt by circulating waters has been set forth by Hanna.[2] This theory holds that water from two

[1]Communication from Donald C. Barton, Houston, Texas.

[2]Marcus A. Hanna, "Secondary Salt-Dome Materials of the Coastal Plain of Texas and Louisiana," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 14, No. 11 (November, 1930), pp. 1469-75.

sources is effective. The first source is shale from which water is forced into the sands at the time of compaction. The second source, and the one which furnishes the maximum amount of water for salt solution, is artesian circulation. The water from the latter source moves down the dip of the more porous formations and then upward around the peripheries of the domes. After moving upward around the domes, the water may pass to the surface through the fractured beds on top of the domes, or it may be dissipated through the more porous beds immediately above the domes.

When this artesian water comes into contact with the salt, it becomes saturated with sodium chloride near the point of contact of the aquifer and the salt. If such a contact is below the top of the salt column, the water ceases to be an effective solvent as it moves higher along the periphery, because it is saturated with respect to the salt. With the removal of peripheral salt, the beds surrounding the domes are forced into the space previously occupied by the salt.

Hanna contends that such a process of undermining of the salt by solution is instrumental in the formation of overhangs and other structure commonly associated with salt domes. In support of this contention, he cites saturated waters around the domes, and the presence of anhydrite between the salt and the surrounding sediments in the undermined areas. He contends that anhydrite around the domes was at one time disseminated through the salt, either as individual crystals or as chunks, and was concentrated as an anhydrite residuum through the solution of the salt matrix.

CAUSE OF BARBERS HILL OVERHANG

Of the possible causes of overhangs listed in the preceding paragraphs, the following are postulated by the writers as most capable of producing the overhang at Barbers Hill. However, it is fully realized that positive evidence of any of these movements or actions is lacking, excepting that of salt solution. These causes, in the probable order of their relative effect in producing the overhang, follow.

Upward and outward movement of the salt.—The upward movement of the salt, diverted in an outward direction by the resistance of the thick cap rock and its overburden, was the principal factor producing the overhang existing in the eastern segment. The overturned fold of the Oligocene, illustrated in section *BB* in Figure 4, found by drilling below the salt overhang on the northeast flank, seems to afford evidence of this type of salt movement here.

The fact that the stratification is regular and the dip and continuity of the sands normal as far inward as 500 feet from the outer edge of the salt and more than 900 feet from the outer edge of the cap-rock overhang, seems to the writers to point to this method as the one of the several described, that was the principal cause of the overhang.

The topography of the hill also suggests fairly recent upward movement. The most recent movement is evidenced by the hill which rises in the west-central part of the dome 42 feet above the surrounding plain. Seeming confirmation of the movement producing the overhang on the eastern segment is shown in the low but distinct semicircular ridge situated almost directly above the overhang on this segment.

No evidence of this upward and outward movement being the major cause of overhang in the western segment has been found, although there are no known opposing data. The few wells through the salt on this flank fail to give decisive information.

Solution of salt by ascending waters.—In both the eastern and western segments of the periphery, considerable anhydrite sand is found beneath the overhanging salt. This is considered positive proof of salt solution as a contributing factor in the formation of the overhang. The proportion of the amount of the overhang caused by this solution compared with that caused by the outward movement of the salt itself can not be stated accurately from present data, but it is believed that the salt-solution method was the lesser cause of the two.

Downbuilding.—Downbuilding may have contributed in a very minor way to the part of the overhang already explored and even possibly in larger amount to an entirely hypothetical decrease in the diameter of the salt stock at depths below present producing levels. Evidence determining such a decrease with depth must await further drilling or geophysical studies.

CONCLUSIONS

The discovery of the overhang at Barbers Hill has stimulated geological and geophysical studies of the causes and extent of the overhang on this dome, and the possibilities of other domes having similar occurrences. It has compelled the rapid development of improved drilling practices which make it possible to drill vertical holes through cavernous cap rock and salt. It has permitted the recovery of large quantities of oil whose existence would otherwise have remained unknown. It is conclusive that future production at Barbers Hill from the present producing horizons will be principally from wells drilled through the overhang and that the reserves still remaining considerably exceed in amount the oil already produced.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 16, NO. 5 (MAY, 1932), PP. 483-493, 5 FIGS.

GEOLOGICAL NOTES

CENTRAL KANSAS UPLIFT

On September 4, 1929, the writer presented a paper, "The Central Kansas Uplift," before the evening session of the Third Annual Field Conference of the Kansas Geological Society at Lead, South Dakota. The title of the paper was listed on page 11 of the itinerary of that conference. Copies of this paper were privately circulated by the writer, and as use of the term "Central Kansas Uplift" has become somewhat common, it has been suggested that the original definition appear in the Association *Bulletin*.

After describing that area in central Kansas in which an Ordovician-Pennsylvanian hiatus occurs, the writer called attention to the presence of northwest-southeast folding in the early Paleozoic formations and to the possibility of the presence of a Caledonian emergence or to an emergence of the age of the Wichita Mountains of Oklahoma and north-central Texas. This folding preceded the pronounced north-south to northeast-southwest mid-Pennsylvanian folding in Kansas, the earlier folding coinciding with Ruedemann's classical grain of the North American continent.

The following is a quotation from the original manuscript.

> I propose to call this entire area of uplift the Central Kansas uplift for want of a better name. The Russell arch of Denison[1] appears to apply to the area of the Fairport anticline. The Barton arch of Barwick[2] is a vague, indefinite term and this area of uplift can not be limited to any one county.... Throughout much of the area, marine deposits appear to be absent from the close of the deposition of the Silurian Dolomite to Pennsylvanian time. The late Pennsylvanian sea slowly covered the area and the highest granite peak yet discovered, a result of the combined folding, was covered in Mid-Shawnee time. I propose the name Central Kansas uplift for that area of "truncated" Mississippian, together with the surrounding area in Central and Western Kansas. Its present form is believed to be caused by Caledonian folding or emergence in a direction parallel to the pre-Cambrian grain followed by Appalachian or Hercynian folding normal to the grain.

[1] A. R. Denison, "Early Pennsylvanian Sediments West of the Nemaha Granite Ridge, Kansas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 10, No. 6 (June, 1926), p. 636.

[2] J. S. Barwick, "The Salina Basin of North-Central Kansas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 12, No. 2 (February, 1928), p. 177.

Though the knowledge of this area has since greatly increased, the original description and definition apply as well to-day as they did three years ago.

L. C. MORGAN

WICHITA, KANSAS
March 12, 1932

BIOHERM AND BIOSTROME

We have received from Professor E. R. Cumings the following statement, which will be of interest especially to those of our members who are working on coral-reef formations.

A bioherm is "any dome-like, mound-like, lens-like, or otherwise circumscribed mass, built exclusively or mainly by sedentary organisms such as corals, stromatoporoids, algae, brachiopods, molluscs, crinoids, et cetera, and enclosed in normal rock of different lithologic character."[1] I would include all true coral and algal reefs under the designation, and all shell beds, crinoid beds, algal banks, et cetera, that have an upstanding form; but not mere layers such as many coral beds, crinoid layers, Cryptozoön layers, et cetera. For these I have recently proposed (in my presidential address at Tulsa) the name *biostrome*, which literally means an organic *layer*. Many so-called reefs belong here.

F. H. LAHEE

DALLAS, TEXAS
March 29, 1932

OCCURRENCE OF STRATA OF BEND AGE IN SIERRA DIABLO, CULBERSON COUNTY, TEXAS[2]

The first comprehensive paper on the stratigraphy of the Van Horn area was written by G. B. Richardson and published by the United States Geological Survey.[3] In this paper Richardson very clearly presents the regional structural and stratigraphic features of the Sierra Diablo, which he states on page 5 to be composed entirely of Hueco limestone north of Victorio Peak. The Hueco limestone, assigned by G. H. Girty to the Pennsylvanian, was shown by Richardson to be lying with great unconformity on the older rocks at the south end of the Sierra Diablo. Later work by Emil Böse[4] and J. W. Beede[5] showed that the Hueco included

[1]E. R. Cumings, *Proc. Indiana Acad. Sci.*, Vol. 39, 1929 (1930), p. 207.

[2]Published with the permission of the Humble Oil and Refining Company.

[3]*U. S. Geol. Survey Folio 194* (1914).

[4]*Univ. Texas Bull. 1762*, pp. 30-31.

[5]*Univ. Texas Bull. 1852* (chart opposite p. 46).

rocks of Permian age, and still later work of Philip B. and Robert E. King[1] suggested that the Hueco down to the unconformity itself is composed entirely of rocks of Permian age. These authors also recognized the unconformity south of Marble Canyon and reported the presence of Pennsylvanian of Strawn age beneath the unconformity at that point. During late February and early March, 1931, the writer discovered the existence of the unconformity north of Marble Canyon and found Paleozoic rocks older than Strawn present in the base of the escarpment. The following note records the presence of Pennsylvanian strata of Bend age.

Strata of Permian age overlap across the truncated edges of the various older formations exposed in the Diablo escarpment. At the southern end of the escarpment, in the vicinity of the Hazel mine, these beds are in contact with the pre-Cambrian Millican formation. Immediately south of Victorio Peak a north-dipping monocline carries the Millican beneath the surface. From here to a point approximately 1 mile south of Marble Canyon, rocks of Permian age form the entire escarpment. At this latter locality beds of Strawn age emerge, and from here northward to a point where the escarpment swings to the west, successively older Paleozoics are present beneath the basal Permian unconformity.

About 1 mile north of the entrance to Marble Canyon and 0.8 mile S. 69° W. of the Figure Two Ranch headquarters, exposures of fossiliferous shale and limestone occur at the base of the Diablo escarpment beneath the basal Permian. This section is not well exposed, being present in a few small foothills and in draws cut through the talus. This outcrop consists of about 20 feet of thin-bedded, sparsely fossiliferous, dark gray limestone which is overlain by a black, fossiliferous, argillaceous shale of which some 50 feet is exposed. This upper shale carries a large and well preserved gastropod and ammonoid fauna in clay-ironstone concretions. Northward from this point, a few scattered exposures of limestone and shale occur along the base of the escarpment. These exposures are apparently related and are probably all Bend in age. Unfortunately, an ammonoid fauna collected from the most northerly exposure of these shales has been misplaced, and circumstances have so far prevented making a second collection from this locality.

A large collection of fossils made from the upper shale at the exposure nearest Marble Canyon was sent to F. B. Plummer, of the Bureau

[1] "Stratigraphy of Outcropping Carboniferous and Permian Rocks of Trans-Pecos Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 13, No. 8 (August, 1929), pp. 907-26.

of Economic Geology at the University of Texas, for identification. Plummer's identifications are not as yet complete, but he has ascertained that this shale fauna is Bend,—specifically, that it is Upper Smithwick. In a letter to the writer, Plummer comments as follows.

Your collection is decidedly different. Practically everything in it is new. ...I have, therefore, felt justified in spending some more time in studying these fossils....There are eight species of pelecypods, four species of brachiopods, eleven species of cephalopods, fourteen species of gastropods, one coral and one bryozoan. With the exception of about five species, I think everything in the fauna is new to science, at least three and possibly four of the genera are new....A list of the genera will not mean much, since most of these genera run throughout the Pennsylvanian and much of the Mississippian. But, on the other hand, these new species are probably all confined to the Bend and most of them to the Smithwick. The identification as Upper Smithwick is definite, because I have most of the ammonites from the Upper Smithwick locality near New Rochelle, for example, *Nuculoceras smithwickensis* n. sp., *Pronorites arkansasensis* Smith, *Gastrioceras circumnodosum*, *Gastrioceras listeri*, *Agathiceras*, *Bendoceras texanum*, *Phaneroceras lenticularis*, *Pleurotoma sansaba*, *Euomphalus smithwickensis*, *Bellerophon smithwickensis*, *Bembexia*, *Leda*, and a few others.

Some of the ammonoids from this exposure will be described and figured by Plummer in his forthcoming paper on Carboniferous ammonoids. The entire fauna will be described, and the stratigraphy will be more fully discussed, in a paper by Plummer and the writer which is now in preparation.

The fauna is a varied and well preserved one, and the identification by Plummer is definite. It is the opinion of the writer that some of the other limestone and shale outcrops represent the Marble Falls and possibly the Barnett. The exposed section of the limestone bears a remarkable lithologic similarity to the Dimple formation of the Marathon area. The fauna also has some points of similarity. Fossils are present in all the outcrops, and it is entirely probable that future collections will make it possible to accurately correlate all the exposures with their equivalents elsewhere in the state.

M. B. Arick

McCamey, Texas
March 23, 1932

INTERPRETATION OF GRAIN OF TEXAS

During the last two years the writer has been interested in the interpretation of magnetic anomaly maps. Many of these maps show structures which are at variance with the generally accepted regional

trends as determined both on the surface and in the subsurface. This variance led to the study of pre-Cambrian exposures and trends in the hope that information so gained would aid in the solution of the magnetics. The following brief note is the result of that study and it is offered here with the idea that it may prove interesting to other geologists and at the same time cause some discussion of this important problem.

Pre-Cambrian exposures in the area under discussion are limited to the Llano, El Paso, and Van Horn regions of Texas, to the Rocky Mountains of New Mexico, and to one outcrop in northern Mexico near the town of Boquillas on the Rio Grande. The schistosity of the rocks in the Llano, or Central Mineral, Region strikes approximately N. 45° W., but in the Van Horn Region the trend is N. 45° E. In the Rocky Mountains

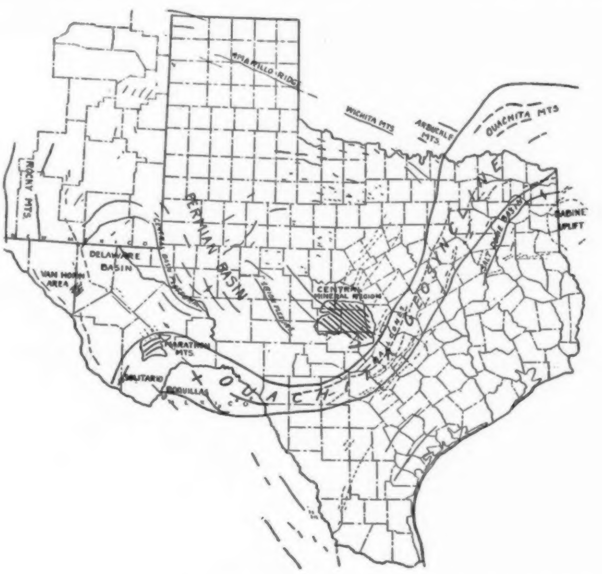

FIG. 1.—Map of Texas and adjoining areas, showing structural trends and schistosity of pre-Cambrian exposures. Faults shown as dashed lines and folds as solid lines. Pre-Cambrian exposures include Llano, El Paso, and Van Horn regions of Texas, Rocky Mountains of New Mexico, and outcrop near town of Boquillas on Rio Grande in northern Mexico. For information contained on this map the author is indebted to A. L. Akers, M. G. Cheney, F. H. Lahee, D. E. Lounsberry, H. J. Morgan, C. H. Row, and W. C. Thompson. Published information has also been freely used. Outline of Ouachita geosyncline is taken from E. H. Sellards.

of New Mexico and near El Paso, the strike of the foliation is generally parallel with the trend of the mountains, or about north and south. Although the pre-Cambrian outcrop in northern Mexico is known to be schistose, the direction of the schistosity has not been recorded so far as the writer is aware. Definite information, therefore, on the pre-Cambrian grain is very meager.

Pre-Cambrian rocks have been encountered in many localities by drilling but, of course, the direction of the schistosity (if there be such) is not known. It may, however, be inferred by the trend of the overlying structure, as is the case in the Panhandle with the Amarillo ridge. The pre-Cambrian trends and later structures are shown in Figure 1.

At the end of pre-Cambrian time, the area of the Ouachita geosyncline must have been much wider than it is now. The close folding and overthrusting of the Ouachita facies suggest that the original geosyncline was more than twice as wide as the present area. This condition is shown

FIG. 2.—Map of Texas and adjoining areas showing conditions at end of pre-Cambrian time. The map has been pulled apart along Ouachita geosyncline *EA*, *FC*. Original Ouachita geosyncline lay between *EB* and *FD*, and amount of shortening caused by folding and faulting of Ouachita facies is equal to *AB*, *CD*. Pre-Cambrian grain is interpreted from information in Figure 1.

in Figure 2. In this figure the map of the state has been cut along the northern and southern limits of the Ouachita geosyncline and pulled apart to represent the original positions of the two segments. The estimated original width of the geosyncline is between 150 and 200 miles.

On this map has been drawn an interpretation of the pre-Cambrian grain. By comparing Figure 2 with Figure 1 it is seen that the control for the grain is taken directly from the structural trends and pre-Cambrian schistosity as exposed in outcrops. The grain is pictured as being a part of one large system, and sudden changes in direction are mapped as twists or bends rather than as opposed trends. Bends or twists in the grain which are worthy of special mention are: (1) the turn in northeast Texas along the western edge of the geosyncline; (2) the sudden twist in the southern portion of the Permian basin, especially in Crockett County; (3) the bend around the northern end of the Delaware basin in southeast New Mexico; (4) a suggested turn along the Rio Grande

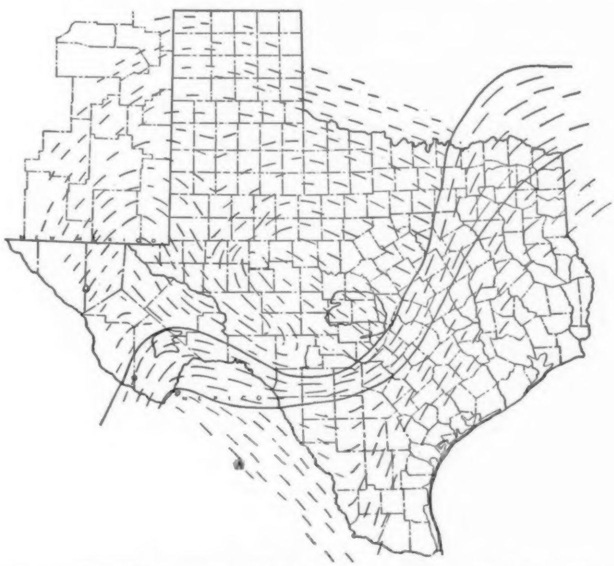

FIG. 3.—Map of Texas and adjoining areas showing pre-Cambrian grain as supposed to be at present. Ouachita geosyncline has been narrowed from original width by late Pennsylvanian folding and overthrusting. Structural trends of syncline have been pushed up to and over trends of area immediately northwest. Except for this movement, Figure 3 is exactly like Figure 2.

in South Texas; (5) the broad curve from the area of the Arbuckle Mountains in Oklahoma through the Panhandle to New Mexico.

In late Pennsylvanian time the southeastern portion of the state was pushed northwest and intense folding and faulting occurred in the Ouachita geosyncline. This folding caused the development of some schistosity parallel with the folding and brought the grain of the southeastern segment up against that on the northwest. In so far as there has been overthrusting along the northwestern edge of the geosyncline, there will be superimposed trends, but it is thought that this condition would not extend very far from the edge.

Many interesting conclusions could be drawn from a study of the figures showing the pre-Cambrian grain, but it is not the writer's intention to discuss these. He prefers that each reader draw his own conclusions.

R. E. RETTGER

SAN ANGELO, TEXAS
February 29, 1932

HUNTON IN KANSAS

It has recently come to my attention that some geologists are using my map of pre-Mississippian rocks in Kansas[1] as a basis for condemning certain areas with respect to Ordovician oil production, under the theory that no oil of commercial importance will be found under the Hunton (Younkin) limestone. Regardless of the possible truth or falsity of this theory I should like to point out a few considerations in connection with the Younkin remnant shown on the map in Reno and Harvey counties.

It is well established that the limestone in question in Harvey County is mostly of Devonian age, but no such proof is available, or was available at the time my paper was published, concerning the western portion of this limestone in Reno and Rice counties. There has been no occasion to change the statement published at that time.

The writer holds the opinion that although the limestone in the Hege well is Siluro-Devonian in age, very probably much of the limestone which seems to be at the same horizon in adjacent areas is, in reality, Kinderhook in age. New evidence may greatly decrease the size of the erosional remnant of Younkin limestone as mapped in the south end of the Salina basin.[2]

[1]Hugh W. McClellan, "Subsurface Distribution of Pre-Mississippian Rocks of Kansas and Oklahoma," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 14, No. 12 (December, 1930), p. 1535.

[2]*Op. cit.*, p. 1546.

The problem of the distribution of the Siluro-Devonian limestone and the Kinderhook limestone, and their relationship to each other, is still unsolved, and the solution awaits the evidence of new wells and the results of detailed research with the microscope.

HUGH W. MCCLELLAN
Consulting Geologist

HUTCHINSON, KANSAS
April 11, 1932

MERIDIAN AREA
LAUDERDALE COUNTY, MISSISSIPPI

Figure 1 shows the surface structure of the area around the city of Meridian, Lauderdale County, Mississippi.

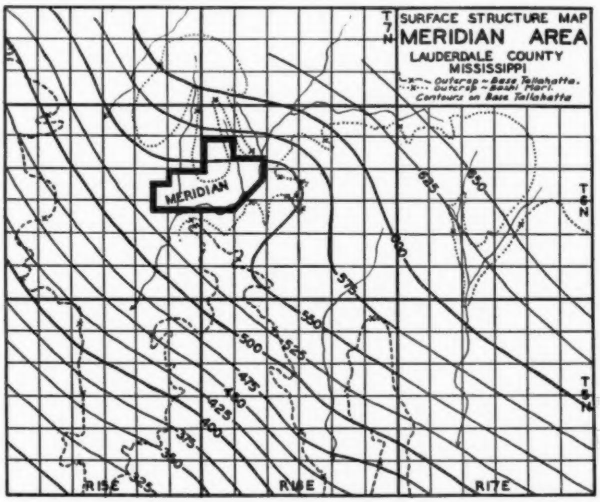

FIG. 1

Outcrops where elevations were run are shown by crosses, the elevations being determined by means of an aneroid. Two horizons were used: (1) the top of the Bashi (Wilcox Eocene), the outcrop of which is indicated by a dotted line; and (2) the base of the Tallahatta buhrstone (Claiborne Eocene), the outcrop of which is indicated by a dashed line. The top of the Bashi is loose greensand, in places weathered brown,

holding the top of the Bashi greensand marl boulders, which are shell-bearing. Immediately above the top of the Bashi are several feet of light gray, brittle clays. The interval from the top of the Bashi to the base of the buhrstone is 193 feet (by aneroid), and was measured in the SE. 1/4 of Sec. 24, T. 6 N., R. 15 E.

The contours are referred to the base of the buhrstone as the datum, and reveal a considerable flattening of the dip in the vicinity of Meridian, that is, the top of the Bashi is very flat in this area.

Fred M. Haase

Kansas City, Missouri
April 8, 1932

LOWER PEACHTREE AREA WILCOX COUNTY, ALABAMA

Figure 1, showing the surface structure of the Lower Peachtree area, Wilcox County, Alabama, is submitted as a slight addition to the valuable work[1] of the Geological Survey of Alabama.

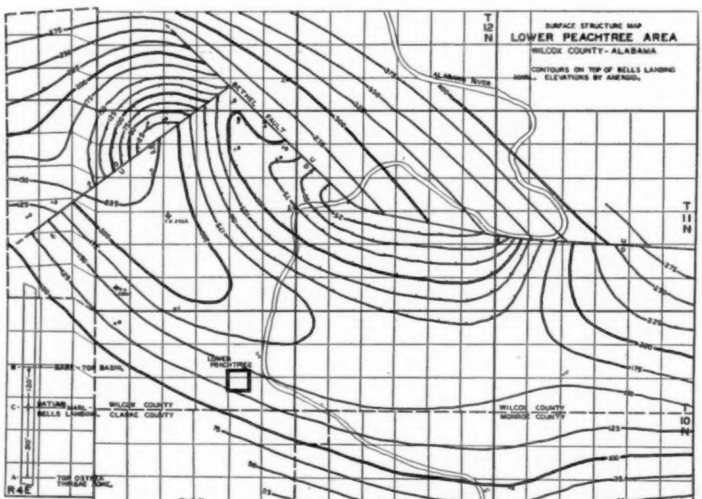

Fig. 1

[1]Douglas R. Semmes, "Oil and Gas in Alabama," *Alabama Geol. Survey Spec. Rept. 15* (1929).

Outcrops where elevations were determined are shown by crosses. Three horizons belonging to the Wilcox group of the Eocene were used, and in ascending order are: (1) the top of the *Ostrea thirsae* zone of the Nanafalia, denoted by *A;* (2) the top of the Bells Landing marl member of the Tuscahoma, denoted by *C;* and (2) the marl at the top of the Bashi, denoted by *B*. The Bells Landing marl was used as the datum, being 210 feet above the top of the *Ostrea thirsae* zone and 120 feet below the Bashi marl.

The most important feature shown in Figure 1 is the fault truncating the northwestern end of the Lower Peachtree anticline. This fault is about at right angles both to the regional strike and the Bethel fault. The fault plane is exposed in Sec. 13, T. 11 N., R. 4 E., where it crosses the Sunny South-Lower Peachtree road, near the township line. The fault plane dips steeply (80°) toward the northwest, or downthrown side. Greensand associated with the boulders at the top of the Bashi is in contact with clays belonging to the upper part of the Tuscahoma. There is accentuated dip toward the fault on both sides for a short distance. Smaller faults also occur in the area, one of which is exposed just west of the bridge across Bear Creek on the Sunny South-Lower Peachtree road.

FRED M. HAASE

KANSAS CITY, MISSOURI
April 8, 1932

THE BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 16, NO. 5 (MAY, 1932), PP. 495-497.

REVIEWS AND NEW PUBLICATIONS

"Correlation of the Big Blue Series in Nebraska." By G. E. CONDRA and J. E. UPP. *Nebraska Geol. Survey Bull. 6*, 2d Ser. (University of Nebraska, Lincoln, 1931).

This paper, following the general plan of Bulletin 1, second series, on the "Stratigraphy of the Pennsylvanian System in Nebraska," gives a valuable summary of the marine lower Permian rocks, as exposed in Nebraska and Kansas.

The old classifications have been revised, old members subdivided, and eighteen new members introduced, in order to identify certain natural subdivisions which have hitherto been unnamed. One new formation, the Barnston, has been made by combining the Florence flint and the Fort Riley limestone. Two members are re-defined.

The report contains a brief description of each group, formation, and member, with nomenclator, date, type locality, and a citation to the original publication; faunal lists; notes on the character, correlation, and distribution in Nebraska, Kansas, and northern Oklahoma; and twenty-eight detailed, measured sections.

The report is illustrated by a map of Kansas and southeastern Nebraska, showing Permian outcrops and the principal structural features; a table showing the revised correlations and thicknesses of the Big Blue series in Nebraska; fourteen photographs of outcrops of various formations and members; and a section across Kansas, showing the relation of the Luta limestone to members of the Winfield formation.

Appended is an annotated bibliography of the Big Blue series, with 132 entries, and an index.

ROBERT H. DOTT

TULSA, OKLAHOMA
April 5, 1932

"The Pre-Carboniferous Exotic Boulders in the So-Called 'Caney Shale' in the Northwestern Front of the Ouachita Mountains in Oklahoma." By W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT. *Jour. Geol.*, Vol. 39, No. 8 (November-December, 1931), pp. 697-714.

In southeastern Oklahoma and southwestern Arkansas occurs an overthrust mass of Paleozoic formations, in nappe structure, entirely foreign to equivalent strata in adjacent areas, and presumably, in the autochtonous overridden floor. These formations were probably deposited in a wide, intercontinental geosyncline, off the North American continental plateau.

In the frontal zone of the Ouachitas in Oklahoma, between the Ti Valley shear zone and the Winding Stair overthrust, and farther south, in the western

part of the mountains, north of the Octavia overthrust, occurs a thin, black shale, intercalated between the shales and sandstones of the Atoka formation and the massive Jackfork sandstone, known as the "Caney." Faunal evidence indicates its Mississippian age, but the real stratigraphic meaning and correlation is in dispute. In many places, the shale is macerated; elsewhere it is undisturbed. It is much thinner than the autochtonous Caney of the area north and west of the Ouachita front.

This "Caney," in the area mentioned, contains boulders and blocks of pre-Carboniferous material, entirely foreign to the Ouachita facies of equivalent strata, and known in the Arbuckle Mountains and elsewhere on the autochtonous overridden floor. The material is mainly limestone, but consists of some sandstone and arenaceous and calcareous shale, in small pieces. In age, it ranges from Arbuckle to Morrow (Wapanucka), and includes fragments from practically every formation in that interval, represented in the Arbuckle Mountains. No pre-Cambrian has been found. The material is irregularly distributed in the shale, does not occur as a bed, and its position in the shale varies from place to place. The boulders and blocks are subangular to rounded, and most of them are weathered and leached. Some are elongated by squeezing, while many are slickensided and gouged. They range in size up to that of a large building. The boulders occur only where the shale matrix is intercalated between the Jackfork and Atoka, and nowhere in the autochtonous Caney on the overridden floor, or even in the area between the Choctaw fault and the Ti Valley shear zone. The occurrence is confined to this association, in a belt 100 miles long, exclusively within the frontal zone of the overthrust sheets.

Previous writers have contended that the blocks and boulders are sedimentary, having been transported to their present position by ice. The following objections to this hypothesis, however, seem overwhelming.

1. Many of the blocks are too large to be transported by ice.

2. The faunal and floral character of the Mississippian and lower Pennsylvanian of the Ouachita and Arbuckle Mountains does not suggest glacial climate.

3. Such a hypothesis would call for some Mississippian folding of sufficient magnitude to expose more than 15,000 feet of beds, within a restricted area, from which these boulders could have reached the equally restricted area in which they are now found. There is no evidence of such folding until after Morrow time.

The most logical conclusion is that these blocks are not of sedimentary origin, but are tectonic blocks, similar to those found in the frontal thrust sheets of many other mountains of nappe structure. Similar blocks are well known in Europe, from the Alpine chains, the Carpathians, Apennines, and the Caucasus. Some of them may have been sheared off the autochtonous surface, others may have been picked up as loose, weathered boulders, on erosion surfaces. They were probably rolled, worn, slickensided, and gouged as they were carried along the thrust plane.

The boulder-bearing streaks in the "Caney" shale are, therefore, probably not "beds" at all, and much of the shale may be a mass of out-rolled Upper Mississippian shale, over which the overlying mass of Atoka has glided relatively to the underlying Jackfork. In other words, the contact is probably only tec-

tonic. This will obviate the previous difficulty of accounting for early Pennsylvanian boulders occurring in an Upper Mississippian shale. The overthrusting occurred later, and this is the main requisite. In the opinion of the reviewer, it may also help to explain the present confusion as to the age of Jackfork and Stanley, and their correlation with beds in other areas, since the position of the "Caney" between the Jackfork and Atoka need no longer be considered as depositional.

ROBERT H. DOTT

TULSA, OKLAHOMA
April 5, 1932

RECENT PUBLICATIONS

CALIFORNIA

"The Eocene Sierra Blanca at the Type Locality in Santa Barbara County, California," by Marvin Francis Keenan. *Trans. San Diego Soc. Nat. Hist.*, Vol. 7, No. 8, pp. 53-84, pls. 2-4, figs. 1-4.

GENERAL

Leitfaden der Tiefbohrtechnik (Textbook of the Technique of Deep Drilling), by Paul Stein. Third, newly elaborated and enlarged edition of *Verfahren und Einrichtungen* (Methods and Equipment for Deep Drilling). (Julius Springer, Berlin, 1932.) 52 pp., 61 figs. 6⅜ × 9½ inches. Paper. Price, RM. 4.20.

"Radium und Helium in Erdöllagerstätten" (Radium and Helium in Petroleum Deposits), by Karl Krejci. *Petrol. Zeits.* (Berlin), Vol. 27, No. 14 (April 6, 1932), pp. 12-14.

NEW MEXICO

Tentative Correlation of Named Geologic Units of New Mexico, compiled by M. Grace Wilmarth, secretary of Committee on Geologic Names (U. S. Geol. Survey, Washington, D. C., February, 1932). Chart, 23½ × 29½ inches.

OKLAHOMA

"Das Oklahoma City Ölfeld" (The Oklahoma City Oil Field), by R. W. Brauchli. *Petrol. Zeits.* (Berlin), Vol. 27, No. 14 (April 6, 1932), pp. 1-12, 9 figs.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 16, NO. 5 (MAY, 1932), PP. 499-525, 1 FIG.

THE ASSOCIATION ROUND TABLE

SEVENTEENTH ANNUAL MEETING
THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
BILTMORE HOTEL, OKLAHOMA CITY, OKLAHOMA
MARCH 24-26, 1932

Executive Committee

Lovic P. Garrett, president; L. Courtney Decius, first vice-president; Frank R. Clark, second vice-president; Frederic H. Lahee, third vice-president; Sidney Powers, past-president.

Technical Program Committee

General.—F. H. Lahee, chairman, assisted by the Oklahoma City committee on the technical program, and by the associate editors.

Oklahoma City Committees

General.—Irving Perrine, chairman; A. H. Richards, business manager; W. H. Atkinson, president, Oklahoma City Geological Society; G. C. Maddox, J. T. Richards, R. M. Whiteside

Technical.—G. C. Maddox, chairman; H. L. Baldwin, Baxter Boyd, Rudolph Brauchli, Richard Conkling, C. E. Hamilton, L. R. McFarland, D. A. McGee, Henry Schweer, G. O. Williams

Reception.—W. L. Miller, chairman; Frank Buttram, R. W. Camp, M. E. Carpenter, H. L. Crockett, Jr., D. A. Green, D. A. McGee, D. W. Ohern

Entertainment.—Roy Dale Jones, chairman; E. P. Critchlow, Glen Grimes, Harlan Grimes, D. L. Hyatt, C. M. Keeler, Bjarne Rossebo, B. W. Sinclair, O. R. Wahl

Trips.—W. W. Clawson, chairman; H. E. Bale, R. L. Boss, C. E. Decker, J. Faust, N. Meland, J. B. Newby, John E. Van Dall

Finance.—R. W. Laughlin, chairman; W. C. Kite, Charles H. Taylor, J. B. Umpleby

Publication.—A. H. Richards, chairman; Hubert Bale, Noel Evans, G. O. Williams

Registration.—J. T. Richards, chairman; Hubert Bale, N. L. Ballard, Noel Evans, Charles N. Gould, C. R. Hoyle, V. E. Monnett, E. A. Paschal, Clarence Sale, C. Schnurr, M. M. Smith, C. W. Wheeler

Ladies' Entertainment.—Wm. H. Atkinson, chairman; Mrs. W. W. Clawson, Mrs. R. D. Jones, Mrs. V. E. Monnett, Mrs. Irving Perrine, Mrs. A. H. Richards

Publicity—Albert S. Clinkscales, chairman; H. R. Barker, Roger Sawyer, W. O. Skirvin

Exhibits.—H. S. Thomas, chairman; Harry Baldwin, M. C. Oakes, C. W. Shannon, Curtis Story

Golf.—F. M. Ricks, chairman; Jack Barcklow, Phil Boyle, George Burruss, W. A. Dawson, Casper Kite, Dean Stacy, E. I. Thompson

Division of Paleontology

The Society of Economic Paleontologists and Mineralogists elected the following officers: G. Dallas Hanna, president; James A. Waters, vice-president; Gayle Scott, secretary-treasurer; Raymond C. Moore, editor.

Society of Petroleum Geophysicists

The Society of Petroleum Geophysicists elected the following officers: Paul Weaver, president; G. H. Westby, vice-president; John F. Weinzierl, secretary-treasurer; Ludwig W. Blau, editor.

Golf Tournament

The annual golf tournament was held at the Nichols Hills Golf and Country Club. Fifty members and 10 guests played. The member winners were as follows: *Class A*, Dean M. Stacy, 82; J. Wallace Bostick, 85; *Class B*, George Burruss, 88; Edwin A. Dawson, 93; *Class C*, Fritz Aurin, 91; C. E. Yeager, 95. The guest winner in the *J. Wallace Bostick Trophy* competition was J. H. S. Bonner, of Wichita Falls, Texas.

Schedule of Events

Wednesday, March 23 (Pre-Convention)

9:00 A. M.	Registration, Main Lobby, Biltmore Hotel
	Exhibits, Main Lobby, Biltmore Hotel
9:00 A. M.	Executive Committee, L. P. Garrett, chairman
10:00 A. M.	Constitution and By-Laws Committee, H. B. Fuqua, chairman
11:00 A. M.	Research Committee, Alex. W. McCoy, chairman
2:00 P. M.	General Business Committee, R. S. McFarland, chairman
	Geologic Names and Correlations Committee, A. I. Levorsen, chairman

Thursday, March 24 (Convention)

7:30 A. M.	Registration, Main Lobby, Biltmore Hotel
10:00 A. M.	Address of welcome, Walter Lybrand, for the Chamber of Commerce, Civic Room, Biltmore Hotel
	Response, L. P. Garrett, president of the Association
10:15 A. M.	Technical session, Civic Room, Biltmore Hotel
1:00 P. M.	Ladies' Musical Tea at University of Oklahoma, Norman
2:00 P. M.	Technical session, Civic Room, Biltmore Hotel
2:00 P. M.	Society of Economic Paleontologists and Mineralogists, Colonial Hall, Huckins Hotel
4:45 P. M.	Nomination of officers, Civic Room, Biltmore Hotel
	Appointment of committees
Night	Group dinner and dancing parties

Friday, March 25 (Convention)

8:00 A. M.	Ballot boxes for election of officers, Main Lobby, Biltmore Hotel
8:30 A. M.	Chi Upsilon breakfast, Y. W. C. A. Building
9:00 A. M.	Technical session, Civic Room, Biltmore Hotel
9:00 A. M.	Society of Petroleum Geophysicists, Colonial Hall, Huckins Hotel
	Joint technical session with Association geophysicists
12:30 P. M.	College and fraternity luncheons. Sigma Gamma Epsilon
1:00 P. M.	Ladies' luncheon bridge, Nichols Hills Golf and Country Club
1:00 P. M.	Annual golf tournament, Nichols Hills Golf and Country Club
2:00 P. M.	Technical session, Civic Room, Biltmore Hotel
2:00 P. M.	Society of Economic Paleontologists and Mineralogists, Colonial Hall, Huckins Hotel
4:00 P. M.	Oklahoma City oil field trip
6:00 P. M.	College and fraternity dinners
10:00 P. M.	Annual ball, Biltmore and Skirvin hotels

SATURDAY, MARCH 26 (CONVENTION)

9:00 A. M. Seventeenth annual business meeting, Civic Room, Biltmore Hotel
Announcement of annual elections
10:00 A. M. Executive committees, joint meeting, 1931 and 1932 officers
10:00 A. M. Technical session, Civic Room, Biltmore Hotel
10:00 A. M. Society of Petroleum Geophysicists. Joint technical session with Association geophysicists, Colonial Hall, Huckins Hotel
10:30 A. M. Ladies' breakfast, Oklahoma Club
12:30 P. M. College and fraternity luncheons
1:00 P. M. Ardmore field trip (Arbuckle Mountains)
2:00 P. M. Technical session, Civic Room, Biltmore Hotel

Technical Program*

GROUP I. MID-CONTINENT AND GULF COAST

1. Structural History of Seminole Uplift, Oklahoma—Ira H. Cram
2. Geology and Development of Oklahoma City Field, Oklahoma County, Oklahoma—W. W. Clawson and D. A. McGee
3. Tectonics of Oklahoma City Structure—L. L. Foley
4. Base Replacement Studies on Oklahoma Shales. A Critique of the Taylor Hypothesis—L. C. Case
5. *†Geology and Occurrences of Natural Gas in Amarillo District—Victor Cotner and H. E. Crum
6. †Shallow Salt-Type Structure in Permian of North-Central Texas—Urban B. Hughes
7. The Concho Divide—M. G. Cheney and Sidney L. Harris
8. †Stratigraphic and Structural Relations of Pre-Carboniferous Formations in Big Lake Field, Reagan County, Texas—E. H. Sellards
9. †Regional Structure of Cretaceous in Edwards Plateau, Texas—Lon D. Cartwright, Jr.
10. *†Natural Gas in West Texas and Southeast New Mexico—R. E. Rettger, J. Ben Carsey, and J. E. Morero
11. †Ouachita Epeiroplain—J. W. Beede
12. †Paleozoic Folding in Trans-Pecos Texas—Philip B. King
13. Geology of East Texas Field—H. E. Minor and Marcus A. Hanna
14. East Texas Paleogeography and Oil Migration—M. G. Cheney
15. Boggy Creek Salt Dome, Anderson and Cherokee Counties, Texas—H. J. McLellan, E. A. Wendlandt, and E. A. Murchison
16. Notes on Pre-Tertiary Rocks in Deep Borings at Jackson, Mississippi—Watson H. Monroe
17. Igneous Rocks of Central Mississippi Embayment Area—C. L. Moody
18. Buried and Resurrected Hills of Central Ozarks—C. L. Dake and Josiah Bridge
19. †The Reynosa Problem—W. Armstrong Price
20. The Reynosa, the Upland Terrace, and Lissie Deposits of the Coastal Plain of Texas between Brazos River and the Rio Grande—A. W. Weeks
21. †Notes on the Salt at Smackover, Arkansas—W. C. Spooner

GROUP II. GEOLOGICAL ASPECTS OF PETROLEUM ENGINEERING

1. †Improved Technique for Determination of Densities and Porosities—H. R. Brankstone, W. B. Gealy, and W. O. Smith
2. Coring in Oklahoma City Field—R. W. Brauchli
3. Geology and Gas-Oil Ratios in Oklahoma City Field—R. L. Clifton
4. Proration at Oklahoma City—Harold S. Thomas
5. Character of Producing Sands and Limes in Wyoming—John G. Bartram

*Papers marked with an asterisk are for a special volume, *Geology of Natural Gas*. Papers marked thus (||) are for *Structure of Typical American Oil Fields*, Vol. III. A dagger (†) indicates papers read by title only.

6. Value of Bottom-Hole Pressures in Geological Interpretations—C. V. MILLIKAN
7. Water Encroachment in Bartlesville Sand Fields of Northeastern Oklahoma—D. R. SNOW
8. †Factors Involved in Segregation of Oil and Gas from Subterranean Water—JAN VERSLUYS

GROUP III. MISCELLANEOUS

1. ||Variation of Gravity with Depth in Mid-Continent—CHARLES H. PISHNY
2. Primary Water Occurrence Directly Overlying Commercially Productive Oil Reservoirs in Oklahoma—T. C. HIESTAND
3. ||Natural History of Petroleum with Special Reference to the Gulf Coast Crude Oil—DONALD C. BARTON
4. ||Hydrogenation and the Origin of Oil—WALLACE E. PRATT
5. Athabaska Oil Sands and Problem of Local Accumulation or Long-Distance Migration of Oil—MAX W. BALL
6.*†Natural Gas Industry—HENRY A. LEY
7. *Natural Gas Other Than the Hydrocarbons—C. E. DOBBIN
8.*†Natural Gas from Paleozoic Horizons in Southern Cincinnati Arch Region—WILLARD F. BAILEY
9. †Natural Gas Fields of Michigan—R. B. NEWCOMBE
10. *Valuation of Natural Gas Properties—EUGENE A. STEPHENSON
11. Pre-Pennsylvanian Stratigraphy of Front Range in Colorado—A. E. BRAINERD, H. L. BALDWIN, and I. A. KEYTE
12. Paleozoic Unconformities in Central Colorado and Their Stratigraphic Effects—T. S. LOVERING and J. HARLAN JOHNSON
13. Some Features of Montana Group of Eastern Colorado—CHARLES S. LAVINGTON
14. †Geology of Northeastern Colorado and Greasewood District—E. W. KRAMPERT
15. Results of Drilling, and Oil and Gas Possibilities in Somerset and Fayette Counties, Pennsylvania—HARLEY S. GIBBS
16. †Geology of McKittrick Oil Field and Vicinity, Kern County, California—J. A. TAFF
17. Geologic Interpretations from Rotary Well Cuttings. Part I. Field Technique—ROBERT M. WHITESIDE
18. Geologic Interpretations from Rotary Well Cuttings. Part II. Laboratory Technique—ROBERT M. WHITESIDE
19. Type Examples Where Primary Water Occurs Directly Overlying Commercial Oil in Kansas—HOWARD S. BRYANT
20. Aerial Photography as Applied to Geology—R. C. KERR
21. †Oil and Gas Prospects of St. Lawrence Valley, Between Montreal and Quebec—L. C. SNIDER
22. †Geology of Cuba—J. WHITNEY LEWIS
23. †New Developments and General Situation in North Germany—KARL F. HASSELMANN
24. Petroleum Possibilities in France—F. G. CLAPP
25. Petroleum Development in Russia—R. C. BECKSTROM
26. †Contribution to Geology and Mining of Petroleum in Poland—CHARLES BOHDANOWICZ
27. †Petroleum Research in North Africa—HENRY DE CIZANCOURT
28. †Faults in Comodoro Rivadavia Field, Argentina—E. FOSSA-MANCINI
29.*†Gas in South America—WILLIAM J. MILLARD
30.*†Natural Gas Fields of Ontario—R. B. HARKNESS
31.*†Natural Gas Prospects in St. Lawrence Valley—L. C. SNIDER and LINN M. FARISH
32. †Structural Study of Branching of Northern Andean System in Colombia and Venezuela—H. DE CIZANCOURT

GEOPHYSICS

(PAPERS BY MEMBERS OF SOCIETY OF PETROLEUM GEOPHYSICISTS)

1. Semi-Portable Alternating-Current Susceptibility Meter—William M. Barret
2. Use of Record Character in Interpreting Results and Its Effect on Depth Calculation in Refraction Work—T. L. Allen
3. Surface Aerated Layer—O. C. Lester
4. Accuracy of Torsion-Balance Determination of Relative Gravity—Donald C. Barton
5. Geophysics of the Soil—Paul Weaver
6. Curvature of Equipotential Surfaces—M. M. Slotnick
7. Sources and Magnitude of Errors Encountered in Reflection Profiling—Burton McCollum
8. Three-Dimensional Magnetic Prospecting—W. P. Jenny
9. Electrical Coring Process—E. G. Leonardon
10. Discovery of Vermillion Bay Salt Dome by Refraction Seismograph—E. E. Rosaire

(PAPERS BY ASSOCIATION GEOPHYSICISTS)

1. Application of Reflection Seismograph—Eugene McDermott
2. Magnetic Resurvey of Oklahoma City Field—O. C. Clifford, Jr.
3. Distribution of Salt Domes in Depth—E. E. Rosaire and M. E. Stiles
4. Measurements of Magnetic Susceptibilities of Some Rocky Mountain Granites —Dart Wantland and C. A. Heiland
5. Preliminary Note on New Magnetometer—C. A. Heiland
6. Advances in Technique and Application of Resistivity and Potential Drop Ratio Methods in Oil Prospecting—C. A. Heiland

PALEONTOLOGY

1. Micro-Fossiliferous Upper Cretaceous Section from South Dakota—J. A. Cushman and E. R. Applin
2. Regional Distribution of genus *Globotruncana* in Upper Cretaceous Sediments—Hans E. Thalmann
3. Micro-Fossils from Upper Part of Trinity near Marietta, Oklahoma—H. C. Vanderpool
4. *Foraminifera* of the Genera *Flabellammina* and *Frankeina* from Cretaceous of Texas—C. I. Alexander and J. P. Smith
5. Mesozoic Conodonts—Frank H. Gunnell
6. Inverted Hinge in Left Valve of *Venericardia Planicosta* Group—Julia Gardner and Edgar Bowles
7. Distribution of *Venericardia Planicosta* Group North and West of Gulf of Mexico —Julia Gardner
8. Unconformities of Weches Formation in Leon County, Texas—H. B. Stenzel
9. *Scutella* bed of East Texas—H. B. Stenzel
10. New Data on Correlation of Lower Oligocene of South and Central America with that of Southern Mexico—James B. Dorr
11. Recent Ostracodes in Relation to Texonomy of Fossil Material—W. H. Taylor
12. Ostracode Horizon in Lower Permian of Cement Area, Oklahoma—R. W. Harris and Frank Worrel
13. Micro-Fauna of Lower Permian of Kansas—Cecil G. Lalicker
14. Representatives of genus *Schwagerina* in Florence Flint of Cowley County, Kansas—Charles Ryniker
15. Contributions to Knowledge of Paleontology of Bend Group—F. B. Plummer
16. Megascopic Fauna of Cromwell Sandstone—R. V. Hollingsworth
17. Heavy Minerals in Springer Formation of Ardmore Basin, Oklahoma—E. L. Lucas
18. Fusulinid Sports—M. P. White
19. New Genus of Fresh-Water Mussel from Catahoula Sandstone of Texas—F. S. MacNeil

20. Arenaceous *Foraminifera* of Pre-Pennsylvanian Age of Western Ozark and Arbuckle Regions—R. W. Harris and H. A. Ireland
21. Concerning Composition of Tests of Early Paleozoic *Foraminifera*—W. L. Moreman
22. Classification of Mississippian System—R. C. Moore
23. Notes on Marine Wilcox—F. W. Rolshausen

Registration

Total registration at the meeting was 894: 1 honorary member, 461 members, 88 associates, and 344 non-members.

Report of President

Membership.—Since the organization of this Association the total membership has steadily increased from year to year up to the present time. The total membership March 1, 1932, including honorary members, life members, members, and associate members, was 4 less than on March 1, 1931; however, the number of members on March 1, 1932, was 71 more than on March 1, 1931, while the number of associate members was 74 less this year than for 1931. We are hopeful that conditions will soon exist whereby delinquent members will be able to continue with the Association.

Finances.—The executive committee, realizing that our revenues for the year 1931 would be considerably reduced, have worked hard during the entire year to reduce our expenses so as to be able to operate within our income. At the same time every effort possible was made to maintain the high standard of the *Bulletin*. I think the executive committee is to be congratulated upon results obtained for the past year.

While you have had presented to you the financial statement for 1931, I do not think it amiss to briefly give you the picture that this statement conveys to me. Our income from memberships in 1931 was $1,945.00 more than in 1930; amount realized from sale of publications was $8,991.40 less in 1931 than in 1930; other income, including advertising, donations, et cetera, was $3,271.77 less than in 1930. In other words, our total income for 1931 was $10,318.17 less than for 1930. However, our entire expense was $14,292.33 less for 1931 than for 1930. After making adjustments for bad accounts and adjustments on inventory, we show a net profit for 1931 of $1,555.29 in excess of profit for the year 1930.

While it is true that the balance sheet shows that our assets have decreased $6,710.95, this is accounted for by a reserve which we have set up to the amount of $2,500.00 for doubtful accounts and an adjustment to market value of bonds which we hold to the extent of $13,413.75. Cash on hand on January 1, 1931, was $8,205.82, being $373.95 less than in 1930. Our investment in bonds and savings certificates amounted to $42,364.33, based on cost on January 1, 1932, or an increase for the year of $4,639.26. We have not only lived within our income but have slightly increased our investments.

One of the problems that has given the executive committee much concern was the question of our investments. Early in the year, faced with a declining market on all securities, it was questionable whether or not certain securities

should be sold. The executive committee, realizing the fact that most of the securities held by the Association would be rated as second or third class securities, and realizing that such securities were depressed more than Grade A securities, were of the opinion that we could not improve the situation by disposing of these securities and purchasing others. After much discussion it was decided that we would not dispose of any securities whatever on the depressed market, and that we would follow the rule of the former executive committee and not purchase any securities other than Grade A. A resolution was passed early in the year to this effect and has been strictly adhered to. The executive committee is fully aware that we probably hold some securities that should be sold and the money reinvested in securities of Grade A type.

After considerable thought and discussion the executive committee has seen fit to recommend to the Association that a committee on finance be appointed, said finance committee to be composed of three men whose terms of appointment shall run for two, four, and six years, respectively;[1] that one additional appointee for a period of six years be chosen at the expiration of each term of service. The duties of the finance committee shall be to study investments of the Association and advise the executive committee regarding the sale of investments, and the reinvestment of Association funds that may be available for that purpose.

Monthly Bulletin.—During the past year the size of the monthly *Bulletin* has been slightly reduced; however, the high standard has been maintained. I think I can say without contradiction that it is the best bulletin of its kind published. The editorial staff has been zealous and painstaking, and deserves the commendation of every member of this Association.

Geophysicists' affiliation with Association.—During the year the Society of Petroleum Geophysicists has applied for affiliation with the Association. The executive committee was very happy to recommend to the Association that the petition of the Society of Petroleum Geophysicists to become a division of the Association be duly ratified by the Association. The executive committee of the Association fully appreciates the advantages that the Association will derive from this affiliation.

Committees.—In addition to the usual committees appointed by the president, the executive committee recommended that the president appoint a committee on geologic names and correlations, and recommended to the Association that this committee be made a permanent committee, subject only to changes caused by resignations or other sufficient reasons. This committee was duly appointed and we feel that it will render the Association valuable service.

During the year the committee on changes in the constitution was dissolved and a new committee of five was appointed to study the constitution and by-laws and to recommend to the business committee any changes or alterations deemed advisable by said constitutional committee. This committee has done commendable work and has brought to the attention of the Association changes in our constitution which should be considered.

[1]By vote of the business committee, these terms were reduced to one, two, and three years, respectively, the terms for the second and later appointments to be three years instead of six years.

International scientific expedition to West Indies.—Under the direction of Richard M. Field, Princeton University is sponsoring an expedition to the West Indies to make a concentrated study of unique geological conditions in that area. The study will combine geophysical studies with tectonics and the sedimentation of the region. The U. S. Hydrographic Office, the Naval Observatory, the Coast and Geodetic Survey, the Royal Society of Great Britain, and the National Research Council are coöperating with Princeton University in the expedition. The American Association of Petroleum Geologists was invited to be represented in official capacity and the executive committee appointed E. DeGolyer as a representative of our Association to confer with the committee representing the expedition. The American Association of Petroleum Geologists is under no financial obligation to the West Indian Expedition.

Joint meeting with Geological Society of America.—During the past year one of the Association's important functions was its participation in a joint meeting with the Geological Society of America at Tulsa, Oklahoma, December 29-31, 1931. At this meeting a symposium was held in which six papers were presented as part of the program of the American Association of Petroleum Geologists. If geology and geophysics can justly be considered under the two categories of pure and applied science, these papers presented the pure science facts which have been discovered and developed through the intense application of geology and geophysics to the search for petroleum deposits, and for which members of our Association have been very largely responsible.

International Geological Congress.—The International Geological Congress which was to have convened in 1932 has been postponed; however, our contribution of $500 for the past year has been paid and it is our information that this $500 was very necessary and highly appreciated by said Congress.

The same difficulties which have confronted the petroleum industry, and each individual, have confronted our Association. Our Association has passed through these trying times in good shape and has really made some financial progress, a fact which in itself should be a source of a good deal of pride to our organization, but we think it is even more important to observe to what extent our profession is fitting into the changing tendencies in the industry.

About thirty years ago, as the industry began to grow in importance in our national life, our pioneer members began to aid in the search for new oil fields, and during the last twenty years the work of these pioneer members has been augmented by an ever increasing knowledge of scientific methods of search for oil, and thus the technique of study of structure and stratigraphy from surface work was amplified by a technique for subsurface work. The study of underground geology of oil fields was begun many years ago merely as a method of checking and amplifying surface observations, and the sole object of the pioneer subsurface work was as an aid to prospecting. As the technique of observing the geology from well cuttings was developed, it was found that many facts were being uncovered which, if systematically studied, would furnish the best basis upon which to plan the development of oil fields and to predict the oil available in them. Thus, during the last fifteen years it has been the function of our membership to aid in the production of oil and to appraise properties which have been brought under production.

As the oil industry has grown increasingly competitive and increasingly essential to our national commerce, a demand has been made upon our Asso-

ciation by the industry not only to increase efficiency in prospecting but also to lower mining costs, and the oil industry has looked to its engineers for better and more efficient equipment, and to the members of our Association for facts that would assist in production methods. Within the last two years many of our members have given the question of how best to lower the lifting cost of oil a great deal of study, and the more we study it the more we find that the value of a pool or property is dependent upon the cost of lifting oil for the life of the property, and the work of geologists for the last two years is pointing to the fact that as new pools are discovered the industry may be much more concerned with the "critical production" that may be obtained from such pool or property than with its potential production for any one day or more. By "critical production" is meant the maximum amount of oil that can be produced from a pool or property per day under a systematic program that will give rise to the cheapest lifting cost for all oil in the pool during its lifetime. Thus, the new standard of estimating the available oil in a new field for any one period may substitute the term "critical production," as previously defined, for the much misunderstood term "potential production," which has been the standard of the industry.

This work on the study of the best method to lower mining costs is now in its pioneer stage and it is too soon to predict what our final conclusions will be, but it should be extremely gratifying to all of us to know that our membership is keenly alive to the problem, that it is really making progress with the problem, and that the membership is adjusting itself to what may become one of the most important transitions in the oil industry. So long as the individual members of this Association continue to meet the changing conditions of the industry with the indomitable spirit of work as they have in the past, the success of this Association is assured.

I wish to take this occasion to express my appreciation to the executive committee. They have worked hard—they have given the Association the very best they had—too, they have been kind and considerate. In my experience I have never been associated with a more able body of men.

I also wish to express my appreciation of the interest that various members have taken in the affairs of the Association. From time to time we have had individual letters from members offering suggestions on various matters pertaining to the welfare of the Association. Such letters were always appreciated and duly considered. One of my regrets is that I have not been able to know each member personally.

LOVIC P. GARRETT, *president*

REPORT OF SECOND VICE-PRESIDENT

MEMBERS

Growth.—The complete membership, as of March 1, 1932, is printed in the March *Bulletin*. We regret the loss by death of nine members since the last annual meeting, as follows.

SALVADOR ORTIZ DAVILA	I. A. KEYTE	THOMAS H. OLDS
CORBIN D. FLETCHER	HOWARD W. KITSON	E. DOUGLAS PHILLIPS
J. CLAUDE JONES	KINGSLEY C. MITCHELL	JOHAN A. UDDEN

The following statistics reveal the growth as well as the present status of our membership.

Total Membership by Years

May 19, 1917	94	March 21, 1925	1,253
February 15, 1918	176	March 20, 1926	1,504
March 15, 1919	210	March 1, 1927	1,670
March 18, 1920	392	March 1, 1928	1,952
March 15, 1921	621	March 1, 1929	2,126
March 8, 1922	767	March 1, 1930	2,292
March 20, 1923	901	March 1, 1931	2,562
March 20, 1924	1,080	March 1, 1932	2,558

Comparative Data	*March 1, 1931*		*March 1, 1932*	
Number of honorary members	7		6	
Number of life members	2		2	
Number of members	1,846		1,917	
Number of associates	707		633	
Total members and associates		2,562		2,558
Increase in membership		270		
Decrease in membership				4
Applicants elected, dues unpaid	43		9	
Applicants approved for publication	21		12	
Recent applications	30		12	
Total applications on hand		94		33
Applications approved for transfer, dues unpaid	51		37	
Applications for transfer approved for publication	3		4	
Recent applications for transfer	11		1	
Total applications for transfer on hand		65		42
Number of members and associates withdrawn	40		58	
Number of members and associates dropped	1		68	
Number of members died	6		9	
Total loss in membership		47		135
Number of members and associates in arrears, previous year	113		243	
Members in arrears, current year	758		951	
Associates in arrears, current year	331		426	
Total number members and associates in arrears, current year		1,089		1,377

Circulation of Bulletin

1. Subscriptions (non-members)				
Libraries	153		158	
Companies	72		70	
Individuals	53		31	
Total non-member subscribers		278		259
2. Exchanges, etc.		78		79
3. Association members and associates		2,562		2,558
Total monthly circulation of Bulletin		2,918		2,896
Loss				22

The accompanying graph shows some interesting data on the growth of the Association.

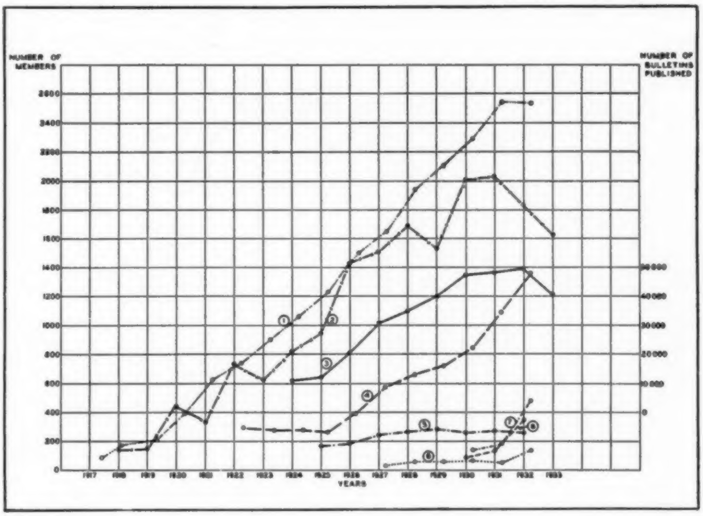

FIG. 1

Curve No. 1.—Membership as of March by years. Membership steadily increased at the rate of 176 per year from 94 in 1917 to 2,562 (1931) in fourteen years. New members for the past year total 131 and 135 withdrew, making a net loss of 4.

Curve No. 2.—Total *Bulletin* pages by years. The size of the *Bulletin* has kept pace with the growth in membership. Vol. 1 (1917) contained 160 pages and Vol. 14 (1930) contained 2,034 pages. The decrease in income necessitated a reduction in the size of the *Bulletin*. Vol. 15 (1931) contained 1,820 pages and Vol. 16 (1932) will contain approximately 1,630 pages.

Curve No. 3.—Total copies separate numbers by years. The number of monthly copies of the *Bulletin* increased to meet the demand, reaching a peak of 49,350 in 1931 and dropping again to 40,800 in 1932.

Curve No. 4.—Total delinquents as of March each year. Special attention is called to the alarming rate of increase in delinquent members. On March 1, 1922, there were 192 delinquents out of 767 members (25 per cent) and on the same date, 1932, there were 1,377 delinquents out of 2,558 members (53⅘ per cent).

Curve No. 5.—*Bulletin* subscriptions (non-members) by years. The demand for the monthly *Bulletin* to non-members increased from 192 in 1924, to 259 in 1931.

Curve No. 6.—Members withdrawn as of March each year (resigned, dropped, and died). The loss in membership, due to resignations, deaths, and being dropped, increased from 33 in 1926, to 133 in 1931.

Curve No. 7.—Total delinquents plus withdrawn members. The number of delinquent members, plus withdrawals, increased from 166 as of March 1, 1929, to 485 as of the same date, 1931.

Curve No. 8.—Total delinquent members, December 31, by years. The number of delinquent members as of December 31, 1929, increased from 94 to 350 as of December 31, 1931.

Geographic Distribution of Members

Membership in the Association is distributed in 43 states and 35 foreign countries; approximately 81 per cent of the membership is within the United States. Texas continues to lead with 709 members; Oklahoma is second with 518 members; California is third with 314 members; Kansas fourth with 95 members; New York fifth with 92. These five states have 1,728 members, or approximately 67 per cent of the entire membership.

Alabama	2	Louisiana	64	Ohio	21
Arizona	2	Maryland	7	Oklahoma	518
Arkansas	12	Massachusetts	12	Oregon	5
California	314	Michigan	14	Pennsylvania	61
Colorado	73	Minnesota	10	S. Dakota	1
Connecticut	7	Mississippi	13	Tennessee	2
Delaware	1	Missouri	35	Texas	709
Dist. Columbia	31	Montana	9	Utah	2
Florida	2	Nebraska	20	Virginia	5
Idaho	3	Nevada	1	Washington	7
Illinois	32	New Jersey	8	W. Virginia	18
Indiana	8	New Mexico	16	Wisconsin	4
Iowa	11	New York	92	Wyoming	12
Kansas	95	N. Carolina	4		
Kentucky	14	N. Dakota	1		

Total members in the United States........2,278

Angola, Africa	1	Czechoslovakia	1	New Zealand	1
Argentina	9	D. East Indies	16	Persia	5
Australia	5	Ecuador	1	Peru	2
Austria	2	Egypt	1	Poland	4
Belgium	1	England	26	Roumania	6
Brazil	4	France	9	Russia	4
B. West Indies	10	Germany	15	Scotland	3
Canada	30	Holland	17	Sweden	1
Chile	1	India	1	Switzerland	12
China	1	Italy	1	Turkey	1
Colombia	7	Japan	4	Venezuela	37
Cuba	8	Mexico	33		

Total members—Foreign........280

Grand Total........2,558

Finances

Annual audit.—A complete audit of the 1931 business of the Association was made by a certified public accountant. The balance sheet, statement of income, and analysis of expenses, were published in the March, 1932, ***Bulletin***. That part of the audit not published includes:

(1) The detailed inventory of all printed matter showing unit cost, number of copies on hand of each *Bulletin*, value of each at cost, and value charged to reserves and the net value as used in the balance sheet.

(2) A schedule of investments by Funds, showing the date of purchase, cost, par value, market value as of December 31, 1931, and the accrued interest.

Association Funds

There are four Funds: General, Publication, Research, and Life Membership.

GENERAL FUND

Income.—The income for the General Fund is derived from membership dues, subscriptions to the *Bulletin*, sale of back numbers, bound volumes, indexes, advertising, and the sale of other publications not credited to special funds. The General Fund carries all the publication expenses of the *Bulletin* and the general overhead. The annual audit is made on the accrual basis and therefore does not represent cash receipts and disbursements.

Comparative Figures on Accrued Income
Years

Items	*1928*	*1929*	*1930*	*1931*
Dues—Members	$20,171.10	$23,972.00	$26,217.50	$28,952.50
Associates	7,044.00	6,848.00	7,520.00	6,730.00
Life		600.00		
Total	$27,215.10	$31,420.00	$33,737.50	$35,682.50
Subscriptions	4,130.04	4,146.53	4,205.32	3,998.90
Bound Volumes	3,916.58	3,605.20	4,704.50	2,648.83
Index	236.90	399.04	101.80	62.72
Back Numbers, etc.	1,379.87	858.40	1,178.45	873.84
Advertising	3,994.74	6,973.95	7,233.14	4,780.90
Salt Dome	791.46	734.66		
Miscellaneous	139.34	121.05	115.65	126.68
Interest on Investments	2,355.13	1,919.36	1,915.30	1,726.12
Convention Receipts			1,550.00	
Special Symposium				482.75
Vol. II Symposium				476.01
Total	$44,159.16	$50,178.19	$54,741.66	$50,859.25
Less Dues	27,215.10	31,420.00	33,737.50	35,682.50
	$16,944.06	$18,758.19	$21,004.16	$15,176.75
Net Accrued Income from published statements	9,273.46	8,999.06	11,608.51	7,836.52

Expense.—The items of expense are shown in Exhibit "C" of the 1931 statement in the March, 1932, *Bulletin.* Several of the main items of expense were materially reduced during 1931, as follows.

Salaries	$1,392.78
Bulletins	1,838.66
Office Expense	368.54
Miscellaneous	1,911.66
Executive Expense	52.59
TOTAL	5,564.23

Further reductions are contemplated and recommended for 1932, amounting to $5,000.00 or $6,000.00. The items recommended for reduction include salaries, printing, and convention expenses.

COMPARATIVE SCHEDULE OF SALARIES

	1928	*1929*	*1930*	*1931*	*1932*
Business Manager	$ 7,500.00	$ 7,500.00	$ 7,500.00	$ 6,833.35	$ 5,000.00
Editorial Secretary	2,896.15	3,254.39	3,998.04	4,054.52	3,600.00
Clerical	3,417.65	3,979.31	6,212.61	5,430.00	4,800.00
TOTAL	$13,813.65	$14,733.70	$17,710.65	$16,317.87	$13,400.00
		Increase	*Increase*	*Decrease*	*Decrease*
		$ 920.00	$ 2,976.95	$ 1,392.78	$ 2,917.87 (Est.)

SCHEDULE OF COMPARATIVE PRINTING COSTS

	1928	*1929*	*1930*	*1931*
Total	$25,777.47	$33,324.18	$34,967.67	$33,129.01
Total number of copies printed monthly	3,300.00	3,900.00	4,000.00	4,250 (Jan.) 4,100 (bal.)
Number monthly copies printed	39,600.00	46,800.00	48,000.00	49,350.00
Number pages printed	1,530.00	2,016.00	2,034.00	1,820.00
Cost per separate	.65	.71	.73	.67
Cost per page for total printed	0.0051	0.0041	0.0043	0.0044

The above cost figures include printing, cloth binding, engraving, printing separates, one-half of the business manager's salary, editorial secretary's salary, 15 per cent of the clerical salaries, stencil corrections and mailing, and constitute the basis for the present cost of inventory.

Inventory.—The sale value of any inventory is largely a matter of judgment and the Association *Bulletins* on hand are no exception. The cost value of the inventory does not usually give its sale value. The inventory value, as of December 31, 1930, was carried on the books as the cost of printing only, and amounted to $15,665.69. The same inventory stock figured at actual cost amounted to $25,633.02. The value of the inventory, December 31, 1931, was $33,198.68, showing an increase for the year 1931, of $7,565.66. After considerable thought and study, it was decided that the cost figure for inventory was

in excess of its sale value by the amount of $13,747.85, which was charged to reserve for obsolescence, leaving a net value for inventory stock of $19,450.83.

The source of the Association's dollar is as follows.

Source	*1930*	*1931*
Dues { Members	$ .48	$ .58
Dues { Associates	.12	.13
Subscriptions	.08	.08
Sale of Publications	.11	.09
Advertising and Miscellaneous	.14	.09
Convention Receipts	.03	
Interest on Investments	.04	.03
	$1.00	$1.00

The use of the Association's dollar has been grouped into two main items.

Use	*1930*	*1931*
Cost of Printing *Bulletin*	$ .65	$ .67
General Expense	.35	.33
	$1.00	$1.00

Publication Fund

The financial status of the Publication Fund is set forth in the annual statement published in the March, 1932, *Bulletin*.

The accrued income was from the following sources.

Profit on Sale of Books	$ 882.35
Profit on Convention Receipts	2,132.53
Donations from Individuals	1,325.00
Interest on Investments	584.80
Miscellaneous	11.76
ACCRUED INCOME	$ 4,936.44

The balance sheets show total assets to be:

1930	15,541.30
1931	13,395.97
Depreciation Loss	$ 2,145.33
This loss is through depreciation of investments in the amount of	3,915.55
and the transfer in August, 1931, of Vol. II to the General Fund	3,166.22
TOTAL	$ 7,081.77

Analysis of Operations of the Publication Fund

	Structure Vol. I	*Structure Vol. II*	*Theory of Continental Drift*	*Total*
Inventory, December 31, 1930	$ 1,641.24	$ 3,585.60	$ 228.52	$ 5,455.36
Inventory, December 31, 1931	1,169.82	*3,166.22	120.17	4,456.21
Sales	902.65	680.37	318.30	1,901.32
Cost of Sales	471.42	419.38	108.35	999.15
Gross Profit	431.23	260.99	209.95	902.17
Total Edition	2,500.00	2,500.00	1,500.00	
Copies on hand December 31, 1929	1,095.00		293.00	
Copies on hand December 31, 1930	564.00	996.00	116.00	
Copies on hand December 31, 1931	402.00	**	61.00	
Number of pages	510.00	780.00	240.00	
Cost (Inventory)	2.91	3.60	1.97	
(Actual)	2.91	3.92½	1.97	
Selling Price when Issued	4.00	4.00	3.50	
Present Selling Price:				
Members and Associates	5.00	5.00	5.00	
Non-Members	7.00	7.00	5.00	

*Cost value of stock, August, 1931, transferred to General Fund.

**798 copies on hand, in General Fund inventory.

Investments

Cost of Investments in bonds and other securities of the Association in all Funds	42,364.33
Market Value, December 31, 1931	28,950.58
Difference showing paper loss	13,413.75

This shows a depreciation of 31⅔ per cent.

1931 Comparative Figures on Investments

	Cost	*Market Value December 31, 1931*	*Depreciation*	*Per Cent*
General Fund, Life Membership Fund	$28,463.88	$19,268.18	$ 9,195.70	32⅓
Publication Fund	12,668.50	8,752.95	3,915.55	31
Research Fund	1,231.95	929.45	302.50	24½
TOTALS	$42,364.33	$28,950.58	$13,413.75	31⅔

1930 Comparative Figures on Investments

General Fund	$27,258.20	$25,459.20	$ 1,799.08	6.6
Publication Fund	9,770.55	9,425.00	345.55	3.5
Research Fund	696.32	696.32		
TOTALS	$37,725.07	$35,580.52	$ 2,144.55	5.6

COST OF BOND INVESTMENTS IN FUNDS BY YEARS

	General	*Publication*	*Research*	*Life*
1924	$ 3,306.20			
1925				
1926	2,865.00			
1927	1,855.00			
1928	7,487.50			
1929	5,702.50			
1930	3,948.75	7,870.55		
1931	2,688.99	4,797.95	1,231.95	609.94
TOTALS	$27,853.94	$12,668.50	$ 1,231.95	$ 609.94

The above cost of investments by years includes both income and reinvestment of money from sales of Association securities.

The total accrued assets in all Funds of the Association. before any deductions for obsolescence and depreciation, at the end of 1931, amounts to	$94,108.67
Amount charged off	30,326.60
TOTAL ACCRUED ASSETS AS PER AUDITOR'S STATEMENT	$63,782.07

The items included in the amount charged off are as follows.

General Fund	
Inventory of Stock	$13,747.85
Doubtful Dues	2,500.00
Depreciation on Investments	9,195.70
Dues of Members Dropped	665.00
TOTAL	$26,108.55
Publication Fund	
Depreciation on Investments	3,915.55
Research Fund	
Depreciation on Investments	302.50
TOTAL	$30,326.60

The main sources of the cash receipts of the General Fund, for 1931, are shown in the following schedule.

Dues — Members	$25,909.30
Dues — Associates	5,950.25
Sale of Bound Volumes	2,648.83
Subscriptions to *Bulletin*	4,062.75
Sale of Back Numbers	782.86
Sale of Index	61.72
Advertising	4,468.90
Miscellaneous	97.23
Sale, Structure Vol. II	132.06
Interest on Investments	1,347.76
Sale of Alberta Symposium	212.57
Sale of Geophysics Symposium	14.00
TOTAL CASH RECEIPTS—1931	$45,688.23

The items of expenditure are shown in Exhibit "C" of the published statement in the March, 1932, *Bulletin.* The only items not directly charged to expense for 1931, in this exhibit, follow.

Donation to the 1933 International Congress	$ 500.00
Bad Debts	3,238.00
Total Cash Receipts from all sources, for the General Fund for the year 1931	45,688.23
Total Expenses for the same period	45,499.23
NET CASH BALANCE, DECEMBER 31, 1931	189.00

FRANK R. CLARK,
Second vice-president in charge of finances

REPORT OF THIRD VICE-PRESIDENT

During the twelve months elapsed since March, 1931, seven more or less distinct enterprises in writing and publication have claimed our attention. Alexander W. McCoy and Sidney Powers have been active in assembling and editing contributions for Volume III of *Structure of Typical American Oil Fields.* This volume, you will remember, is not to be a further compilation of papers on individual fields, like Volumes I and II, but is to be as far as possible an analysis and discussion of many of the problems still unsolved in petroleum geology. There are now six papers for Volume III ready for the printer; eleven which are being edited; twenty-two in course of preparation or of revision; and fourteen promised.

For the volume on *Geology of Natural Gas*, authorized at our last annual business meeting, considerable progress has been made through the able editorial leadership of Henry A. Ley. Eleven manuscripts have been received, and twenty-six more are promised and confirmed.

Sidney Powers has been energetic in soliciting, editing, and compiling papers for the symposium, *Occurrence of Oil in Igneous and Metamorphic Rocks.* Practically all these papers have now been received. They will be printed as a symposium number of the *Bulletin* in the late spring or early summer.

In December, as a result of earlier persuasion by W. E. Wrather and Sidney Powers, the Geological Society of America held its annual convention in Tulsa. At this convention, by invitation, several members of our Association offered a group of papers relating to contributions of petroleum geology and geophysics to pure geology. Some of these papers, which were presented by Powers, McCoy, Decius, Hanna, Lahee, Karcher, and Heiland, are to be printed together in the Bulletin of the Geological Society of America.

Our October *Bulletin* was devoted to a memorial symposium, dedicated to the late Donaldson Bogart Dowling, on *Stratigraphy of Plains of Southern Alberta.* To the Alberta Society of Petroleum Geologists and in particular to the editing committee, composed of Messrs. Link, Irwin, Slipper, D. L. Powers, and Robin Willis, much credit is due for this group of papers.

The geophysical papers submitted to the Association were printed as a symposium in the November and December issues of the *Bulletin.* A limited

number of these sets of geophysical papers were bound for separate distribution.

I have mentioned six of our publication enterprises. The seventh, and major one, is the *Bulletin* itself. As in former years, I want to make a few statistical comparisons. In 1929 we printed 1,612 pages of major and minor articles; in 1930, 1,610 pages; and in 1931, 1,476 pages. Under minor articles I am including the departments of Geological Notes, Discussion, Research Notes, Reviews, Association Round Table, Memorial, and At Home and Abroad. Of front and back matter, with Roman pagination, we printed 334 pages in 1929; 358 in 1930; and 296 in 1931. The total number of pages in the *Bulletin*, exclusive of covers, was 1,946 in 1929; 1,968 in 1930; and 1,772 in 1931. The average monthly number of majors and minors in 1929 was 134.33; in 1930, 134.16; and in 1931, 123. The average monthly number of printed pages (majors, minors, and Roman) was 162.16 in 1929; 164 in 1930; and 147.66 in 1931.

In 1931 we published 1,065 pages of majors; 62 of Geological Notes; 46 of Discussion; 3 of Research Notes; 56 of Reviews; 124 of Round Table; 10 of Memorial; and 45 of At Home and Abroad. (Total minors, 366 pages.) To this total of 1,431 pages (1,065 + 366) must be added 45 numbered blank pages, making the grand total of 1,476 pages.

It is interesting to compare the number of pages contributed by our membership in the several districts with the number of members and associates in these districts. In making this tabulation, I have placed in column *A* the number of pages in the 1931 *Bulletin* on topics relating to the districts concerned, and in column *B* the number of pages on philosophical subjects of general application but written by members or associates of the districts as designated.

District or Area	*Members and Associates in District March 1, 1932*	*Percentage of Whole Membership*	*Pages in 1931 Bulletin*			*Percentage of Pages in 1932 Bulletin*
			A	*B*	*AB*	
Pacific	327	12.8	90.5	48.5	139	11.8
Rocky Mountains	101	3.9	17	7	24	2
Wichita	117	4.6	42		42	3.6
Oklahoma (E. & W.)	518	20.2	43	43.5	86.5	7.4
Texas, incl. N. Mex. and van der Gracht paper	725	28.3	304.5	22	326.5	27.8
Great Lakes	114	4.5				
Shreveport	93	3.6	66	11	77	6.6
Capital	48	1.9		31	31	2.6
Appalachian	116	4.5	13	4	17	1.4
New York	119	4.7	38	22.5	60.5	5.1
Canada	30	1.1	196	19	215	18.3
Mexico	33	1.3	27		27	2.3
Venezuela	37	1.5	35		35	3
Other foreign	180	7.1	82	13	95	8.1
	2,558	100.0	954.0	221.5	1,175.5	100.0

A careful analysis of the major articles, geological notes, and discussions appearing in the *Bulletin* during 1931 revealed the following distribution of subject matter.

Papers on	*Pages*
Structural Geology	481.5
Stratigraphy and Paleogeography	318
Philosophy, Theory, Experimentation	194.5
Geophysics	106
Engineering	12
Miscellaneous Subjects	63.5
	1,175.5

As brought out by this classification, we are very deficient in papers relating to petroleum engineering. Such subjects as bottom-hole pressures, original fluid conditions in and adjacent to an oil or gas reservoir, porosity and permeability of rock strata, and water encroachment, are strictly geological. They are of vital importance to the industry. I believe that we owe it to ourselves and to our profession to organize for the promotion of more interest and more activity among our members in this branch of our science. In line with this thought, your attention is called to the papers listed in Group II of our technical program. I am hoping that these and other similar contributions may be grouped together in some issue of our *Bulletin* for 1932. We need more such papers if we would keep abreast of our rapidly developing science.

In closing this third year of my service as third vice-president of our Association, I am going to yield to the temptation of saying a few words about our editorial policy. These words are addressed to the membership at large, both contributors and readers, and to those who have assisted or may assist in editing our publications.

To understand this policy, we must bear in mind two vital factors, namely, the diversity of our membership and the demands for economy.

Our membership is composed of many kinds of scientists with various interests. Some are field workers; others are laboratory workers. We have among us geologists, stratigraphers, paleontologists, geophysicists, chemists, and engineers. A large proportion of our membership is American, but we are also glad to say that our roster includes the names of many foreign geologists. I think it is our duty, in our publications, to appeal to the diverse interests of our members. Although our papers, directly or indirectly, should bear upon petroleum, nevertheless we should not confine the subject matter within too narrow limits. In the course of a year the *Bulletin* should contain at least several papers which have a definite personal value for each one of our members. It should serve as a fair cross section of both the geographic distribution and the scientific activities of our membership.

During the past year we have been striving for economy. From a total of 1,610 pages in 1930 the *Bulletin* was reduced to 1,476 pages in 1931. By an executive resolution, we are still further reducing the monthly average number of pages of majors and minors for 1932 to 115. This will bring Volume 16, in 1932, to the size of Volume 11, in 1927. To adhere to this figure requires con-

siderable thought and care on the part of the managing editor. It is sometimes necessary to print papers not quite in the order of their receipt. But what I want most to impress is the fact that the space for minors, including geological notes and discussions, cannot be entirely elastic. Obviously it is restricted due to these efforts to economize, and therefore authors should be reasonable in their requests for early publication and patient in the event that publication is delayed. And furthermore, we ask authors of both major and minor articles to use their best judgment in trying to confine their papers to the real essentials of their theses.

As with any high-grade periodical, we have aimed at a certain degree of uniformity of phraseology in editing papers submitted for *Bulletin* publication. I do not believe that this policy should be carried too far, certainly not so far that it destroys individuality of expression. It is one of the functions of the headquarters editorial staff to correct errors in spelling, punctuation, and English usage, but changes in wording should be with the author's approval. I do not consider that this kind of routine editing should be part of the duty of the associate editors, except with the author's express consent. The associate editors should serve chiefly in the broader capacities of soliciting papers, informing authors of general editorial procedure, passing upon the merits of contributions on the geology in their own provinces, and so on.

There are two relatively small groups within our Association, which have diametrically opposite views of what we should or should not publish. One of these groups maintains that the papers which we print on specific oil fields appear so late in the life of the field that they are practically post mortem. The other group as vigorously holds that we should not publish information on a producing field until development has ceased. I can not enter upon a lengthy argument here, but will say that the value of our *Bulletin* depends in a large measure upon its being up-to-date and progressive; that in all the thousands of pages which we have printed, there are extremely few instances, if indeed there are any, where the author transgressed his obligations to his company or his client; and that the scientific gain to each of those who read the *Bulletin* far offsets any slight loss which he may imagine he has suffered as a result of publication of some local data. Although there are many sides to this problem, I am convinced that reasonably early printing and candid discussion of facts which are made available for publication mean progress for all.

In concluding, I want to thank Mr. Hull and his editorial staff at headquarters for their continuous and persistent efforts toward the attainment of the excellent results which we possess in our *Bulletin*, and I want to express my gratitude to our associate editors for their valuable assistance and advice.

FREDERIC H. LAHEE,
Third vice-president in charge of editorial work

REPORT OF RESEARCH COMMITTEE

The research committee of The American Association of Petroleum Geologists has continued studies begun in 1929. These studies constitute an analytical review of the published data to date relating to the genesis and accumulation of petroleum and natural gas. The discussions of these problems have

been designed to consider the facts,—especially those presented in Volumes I and II of the symposium *Structure of Typical American Oil Fields*, and all other pertinent published or unpublished information. It is hoped that definite conclusions and summaries will be made where possible from the available data. In cases subject to differences of interpretation, all possibilities are to be enumerated. Definite suggestions are to be offered for the work necessary in accomplishing a final solution to such problems. In this manner, the research committee hopes to inventory the known facts and determine the present status of theories important to petroleum geology in order that a definite program for future research may be established.

The results of these studies have been planned for separate publications as Volume III of the structure symposium, and a special volume, *Geology of Natural Gas*. The number of contributions expected for these publications has grown to more than fifty for Volume III, and thirty-six for the gas volume, at the present time. During the last year, it has been planned to have all contributions in to the editorial committee by June 1, 1932. The editorial work should be finished during the summer months and the publications should be at press by the latter part of the summer. This is a delay in contemplated publication of approximately one year. Such delay has been justified by additional study, which was necessary for certain problems, and the inadvisability of attempting an extended publication program under the critical financial strain of affairs generally. The committee feels that further delay in this publication work would probably be detrimental to our future research program and for that reason recommends to the executive committee the appropriation of sufficient funds for publication, first, of the gas volume, and, second, Volume III of the symposium, during this year.

The editorial committee, headed by Sidney Powers, as chairman, for Volume III, and Henry Ley for the volume on natural gas, have expended much time and effort in reviewing the papers which have been submitted and in soliciting additional papers in order to round out the program.

During the year, the research committee has been approached in behalf of several worthy projects in connection with which an appeal has been made for funds from the Association to further research on local problems. In all cases, the committee has discouraged the applicants in such appeals because of the serious character of financial affairs. In no case has the committee recommended expenditure of funds for such problems.

ALEX. W. MCCOY,
Chairman, Research Committee

MINUTES, SEVENTEENTH ANNUAL BUSINESS MEETING, BILTMORE HOTEL, OKLAHOMA CITY, OKLAHOMA, MARCH 26, 1932

MAX W. BALL, *presiding*, *vice* LOVIC P. GARRETT

The minutes of the sixteenth annual meeting were not read, by unanimous consent.

REPORT OF BALLOT COMMITTEE

The ballot committee submitted the following report, and the officers shown as receiving the highest number of votes for the respective offices were declared elected. Nominations for officers of the Association were made in open meeting, Thursday afternoon, the first day of the meeting. Ballot boxes were open all day Friday. Total ballots, 354.

For president,	Frederic H. Lahee	194
	Frank R. Clark	160
For first vice-president,	Robert J. Riggs	176
	R. Clare Coffin	171
For second vice-president,	William B. Heroy	unanimous
For third vice-president,	Ralph D. Reed	unanimous

REPORT OF RESOLUTIONS COMMITTEE

The following resolutions, recommended by the resolutions committee, were unanimously adopted.

Be it resolved, that we express our appreciation and thanks to the following who have contributed to the success of the seventeenth annual meeting in Oklahoma City.

1. The city of Oklahoma City for the excellent facilities given the Association for holding its meetings and its hospitality to the members and their wives.

2. The Oklahoma City Chamber of Commerce for assisting the local society in many ways in making the convention a success.

3. The Biltmore Hotel and its management, especially Mr. Adams and Mr. Durkee, the assistant managers, as well as the Huckins Hotel, in which part of the meetings were held.

4. The Oklahoma City Geological Society, W. H. Atkinson, president, and the various committees who assisted the officers of the Association in making the convention a complete success.

Be it resolved, that these resolutions be spread upon the records of the Association, and that a copy of each specific resolution be mailed to the individuals, societies, and organizations mentioned.

REPORT OF BUSINESS COMMITTEE

The following recommendations of the business committee were moved by R. S. McFarland, chairman, and carried by the Association.

1. *Public relations committee.*—That a committee on public relations be appointed by the president, the object of this committee being to advise and promote ways and means for informing the general public in regard to the natural occurrence of oil and gas underground, the methods of searching for these substances, and the methods of exploiting them.

2. *Committee on geologic names and correlations.*—That the committee on geologic names and correlations appointed by president L. P. Garrett be made a permanent committee subject only to changes caused by resignation or other sufficient reason.

3. *Finance committee.*—That the business committee approve of the resolution of the executive committee to recommend to the Association that a committee on finance be appointed by the president, said finance committee to be composed of three men whose terms of appointment shall run for one, two, and three years respectively; that, after the expiration of the term of each of these first three appointments, and thereafter, one new appointment for a period of three years shall be made each year; that the duties of this finance committee shall be to study investments of the Association and advise the executive committee regarding the sale of securities and the investing and re-investing of Association funds.

4. *Association seal.*—That the future disposition of the matter of an Association seal be left entirely to the executive committee. (The Association at the last annual meeting adopted a design for the Association seal and instructed the executive committee to have the seal printed and to secure bids for the manufacture of the seal as an emblem. The executive committee found the seal as adopted by the Association impractical, mainly because of the great amount of detail in the adopted seal.)

5. *Official editor of special volumes.*—That Sidney Powers be designated the official editor of Volumes I and II of the symposium *Structure of Typical American Oil Fields*, which was published by the Association. It was moved from the floor and carried, that official designation of the editorship of Volume III of this symposium be left to the executive committee.

6. *Society of Economic Paleontologists and Mineralogists.*—That a contribution of $2.00 per member be paid by the Association to the Society of Economic Paleontologists and Mineralogists for each member of the Society who is also a member of the Association and who pays dues to the Association.

7. *Society of Petroleum Geophysicists.*—That the application of the Society of Petroleum Geophysicists to become affiliated with the Association as a technical division be accepted by the Association, and that the Society be established as a technical division of the Association, subject to such arrangements and restrictions as the executive committee may prescribe.

8. *Affiliated societies.*—That the application of the East Texas Geological Society, Tyler, Texas, of the Panhandle Geological Society, Amarillo, Texas, and of the Shreveport Geological Society, Shreveport, Louisiana, for affiliation with the Association, be granted.

9. *United States Geological Survey.*—That the following resolution be sent to the chairmen of the committees on appropriations in the United States Senate and House of Representatives, with copies to the secretary of the Department of the Interior and to the director of the United States Geological Survey.

The American Association of Petroleum Geologists, representing geologists of forty-three states, assembled in annual convention, has heard with regret of the proposed reduction of appropriations for the Department of the Interior, which presumably affects the Geological Survey. The delegates to this convention are unanimously of the opinion that any reduction of the helpful activities of the Geological Survey during this period of economic stress will be harmful to the proper development of the country's resources. As petroleum geologists, we believe that the unrestricted services of this bureau are essential to effective development of our natural resources and their wise conservation.

10. *Bureau of Mines.*—That the following resolution be sent to the chairmen of the committees on appropriations in the United States Senate and House of Representatives, with copies to the secretary of the Department of Commerce and to the director of the United States Bureau of Mines.

> The American Association of Petroleum Geologists, representing geologists of forty-three states, assembled in annual convention, has heard with regret of the proposed reduction of appropriations for the Department of Commerce which presumably affects the Bureau of Mines. The delegates to this convention are unanimously of the opinion that any reduction of the helpful activities of the Bureau of Mines during this period of economic stress will be harmful to the proper development of the country's resources. As petroleum geologists, we believe that the unrestricted services of this bureau are essential to effective development of our natural resources and their wise conservation.

11. *Report of committee on changes in constitution and by-laws.*—Mr. McFarland stated that the committee on constitution and by-laws, after careful study, had recommended certain amendments to the constitution and by-laws of the Association, which amendments the business committee now recommended to the Association for adoption, and asked H. B. Fuqua, the chairman of the committee on constitution and by-laws, to read the recommended changes. E. A. Stephenson thereupon moved the following resolution, which was duly seconded.

> *Resolved*, that without being here read the amendments to the constitution and by-laws recommended by the business committee be favorably acted on, so that they may be submitted to the membership by mail ballot as in the constitution provided.

The chair ruled the motion out of order as not in accordance with Article VII of the constitution relating to amendments, and asked Mr. Stephenson to appeal to the house. Mr. Stephenson then moved an appeal, which was seconded, and after full discussion, during which Mr. Hull estimated that the cost of submitting the changes to mail ballot would be about $200, the appeal was sustained by a substantial majority, taken by rising vote. After further discussion, during which the nature of the proposed amendments was outlined, Mr. Stephenson's resolution was put and adopted by a large majority.

The meeting adjourned.

MAX W. BALL, *chairman*
FRANK R. CLARK, *second vice-president*

BALLOT COMMITTEE

JOHN E. ADAMS, *chairman* — E. P. HINDES — F. A. MORGAN

RESOLUTIONS COMMITTEE

R. A. CONKLING, *chairman* — FRANK W. DEWOLF — T. S. HARRISON

CONSTITUTION AND BY-LAWS COMMITTEE

H. B. FUQUA, *chairman*
C. E. DOBBIN — R. S. MCFARLAND — F. A. MORGAN — W. C. THOMPSON

BUSINESS COMMITTEE

R. S. McFarland, *chairman* David Donoghue, *vice-chairman*

Frank R. Clark, *secretary*

S. P. Borden	J. B. Headley[2]	J. E. Morero	S. C. Stathers[5]
J. P. Bowen	L. G. Huntley[3]	John M. Nisbet	Willis Storm[6]
R. Clare Coffin	L. W. Kesler	Ed. W. Owen	Theron Wasson[7]
H. B. Fuqua	R. S. Knappen	Sidney Powers	J. F. Weinzierl
L. P. Garrett	F. H. Lahee	A. H. Richards	
W. R. Hamilton[1]	C. R. McCollom[4]	Gayle Scott	

[1]Hamilton represented by A. F. Truex
[2]Headley represented by Edgar Kraus
[3]Huntley represented by R. E. Somers
[4]McCollom represented by Glen M. Ruby
[5]Stathers represented by Wm. M. Barret
[6]Storm represented by Leonard W. Orynski
[7]Wasson represented by E. A. Stephenson

EXECUTIVE COMMITTEE MEETINGS
OKLAHOMA CITY, OKLAHOMA, MARCH 23 AND 26, 1932

On March 23, preceding the seventeenth annual meeting of the Association, the outgoing executive committee met at the Biltmore Hotel, Oklahoma City. In addition to routine business, the committee approved for acceptance by the Association the petitions of the following geological societies: East Texas, Shreveport, and Panhandle.

On March 26, following the annual business meeting of the Association, the joint meeting of the outgoing and incoming committees was held. It was decided to consider the time and place for the next annual meeting of the Association at the next meeting of the committee.

ASSOCIATION COMMITTEES

EXECUTIVE COMMITTEE

FREDERIC H. LAHEE, *chairman*, Sun Oil Company, Dallas, Texas
WILLIAM B. HEROY, *secretary*, Sinclair Exploration Company, New York, N. Y.
LOVIC P. GARRETT, Gulf Production Company, Houston, Texas
ROBERT J. RIGGS, Indian Ter. Illum. Oil Company, Bartlesville, Oklahoma
R. D. REED, The Texas Company, Los Angeles, California

GENERAL BUSINESS COMMITTEE

FRANK A. MORGAN (1933), *chairman*, 856 Subway Terminal Building, Los Angeles, California

C. A. BAIRD (1933)
R. CLARE COFFIN (1933)
HERSCHEL L. DRIVER (1933
H. B. FUQUA (1933)
LOVIC P. GARRETT (1933)
S. A. GROGAN (1933)
W. R. HAMILTON (1933)
J. B. HEADLEY (1933)
WILLIAM B. HEROY (1933)
L. G. HUNTLEY (1933)
HARRY R. JOHNSON (1933)
L. W. KESLER (1933)
R. S. KNAPPEN (1933)
FREDERIC H. LAHEE (1934)
THEODORE A. LINK (1933)
JOSEPH E. MORERO (1933)
ED. W. OWEN (1933)
R. D. REED (1933)
A. H. RICHARDS (1933)
ROBERT J. RIGGS (1933)
S. C. STATHERS (1933)
NORMAN L. THOMAS (1933)
H. J. WASSON (1933)
THERON WASSON (1933)
JOHN F. WEINZIERL (1933)

RESEARCH COMMITTEE

ALEX. W. MCCOY (1935), *chairman*, 919 East Grand Avenue, Ponca City, Oklahoma
DONALD C. BARTON (1933), *vice-chairman*, Petroleum Building, Houston, Texas

R. D. REED (1933)
W. T. THOM, JR. (1933)
F. M. VAN TUYL (1933)
W. E. WRATHER (1933)
M. G. CHENEY (1934)
K. C. HEALD (1934)
F. H. LAHEE (1934)
H. A. LEY (1934)
R. C. MOORE (1934)
F. B. PLUMMER (1934)
C. E. DOBBIN (1935)
A. I. LEVORSEN (1935)
C. V. MILLIKAN (1935)
L. C. SNIDER (1935)
L. C. UREN (1935)

CONSTITUTION AND BY-LAWS

H. B. FUQUA, *chairman*, Box 737, Fort Worth, Texas

C. E. DOBBIN
R. S. MCFARLAND
F. A. MORGAN
W. C. THOMPSON

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BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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Memorial

WILLIAM PETER HASEMAN

William Peter Haseman was born on a farm near Linton, Indiana, May 4, 1878. He was one of an illustrious family of scientists. He was graduated from High School, from Normal School, and received his A. B. degree from the University of Indiana in 1903. From 1903 to 1905, he was an instructor in physics in the University of Indiana, receiving his A. M. degree in 1905. He married Emma D. Strietelmeirer in September, 1905. For the next two years, he was a fellow in the University of Pennsylvania, and received the degree of Doctor of Philosophy from the University in 1907. He then returned to the University of Indiana and was assistant professor of geology there from 1907 to 1909. He then came to the University of Oklahoma and was head of the department of physics from 1909 to 1917. He left the University to become associated with Professor C. H. Taylor in petroleum work. In 1921, he assisted in the organization of The Geological Engineering Company of Oklahoma City, where he undertook the first active research work in America by means of seismograph methods for the location of geological structures. From 1922 to 1928, he was chief of research for the Marland Oil Company. After leaving the Marland Oil Company, he was actively engaged in independent research in geophysics and in various petroleum problems until the time of his death.

Dr. Haseman was director of the Oklahoma State Bureau of Standards from 1915 to 1918; a member of the Oklahoma Academy of Science, the American Association for the Advancement of Science, The American Association of Petroleum Geologists, the American Physical Society, and the Sigma Xi Honorary Scientific Society.

It is seldom that one family produces as many sons noted for their scientific activities and research. Twelve degrees were given by the University of Indiana to members of this family, and seven degrees by other universities. The oldest brother, Joseph Henry, lives in Linton. His brother Charles was professor of mathematics at the University of Nevada until his death in 1931. Dr. Leonard Haseman is professor of entomology at the University of Missouri. Dr. John Haseman is an eminent explorer who has written a number of important books on South America and its resources. His sister, Dr. Gertrude Haseman, has been until recently professor of mathematics in the University of Indiana and she was formerly at Byrn Mawr College in Philadelphia. Just this past year his daughter, Marthena, received her A. B. degree from the University of Indiana.

Dr. Haseman wrote a number of scientific papers dealing with the oil industry. Among these may be mentioned: "The Profits and Proper Spacing of Oil Wells," "Geophysical Methods Used in the Oil Industry," "The Use of the Seismograph," and many others. He was a pioneer in the study of geophysics and was engaged during the World War at Washington in the Bu-

reau of Standards working on many of the problems involving physics and geophysics. At the time of his death in Oklahoma City on March 14, 1932, he was actively engaged in advanced geophysical studies.

He is survived by one daughter, Marthena, two sisters, and five brothers.

As a teacher, he inspired hundreds of young men and women to strive for things worth while. His keen ability in research commanded the respect of all his co-workers in science, and he was loved by all who knew him. He was indeed a true friend.

IRVING PERRINE

OKLAHOMA CITY, OKLAHOMA
March, 1932

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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AT HOME AND ABROAD

GEORGE R. PINKLEY, consulting geologist of San Antonio, Texas, has an article, "Oil Field Data Basis for Determining Recovery—New South Texas Discoveries," in *The Oil Weekly* of April 11.

Deutsche Geologische Gesellschaft (German Geological Society) held a petroleum convention in Hannover, May 5, 6, and 7. Papers were presented on the geology and search for petroleum in Germany, particularly in Hannover.

J. A. ALLAN, professor of geology at the University of Alberta, at Edmonton, was elected president of the Canadian Institute of Mining and Metallurgy at the annual meeting in Montreal.

ROSS L. HEATON gave a paper on "Sundance and Related Formations of the Rocky Mountain Region," before the Rocky Mountain Association of Petroleum Geologists at Denver, Colorado, April 4. The paper was published in *The Inland Oil Index* of April 8.

H. B. GOODRICH, consulting geologist of Tulsa, Oklahoma, has an article "Early Discoveries of Petroleum in the United States," in *Economic Geology*, March-April, 1932.

World Petroleum for March contains an article on "Western Kansas—A New Oil Empire," by Basil B. Zavoico, consulting geologist and economist of Tulsa, Oklahoma.

FRANK B. CARTER has changed his address from Los Angeles to 156 South Palm Drive, Beverly Hills, California.

C. L. SEVERY, of Tulsa, Oklahoma, went to Alaska in connection with gold-mining interests there.

SCOTT TURNER, director of the United States Bureau of Mines, Washington, D. C., is president of the American Institute of Mining and Metallurgical Engineers.

G. R. HENSON, of the production department of the Shell Petroleum Corporation at Tulsa, Oklahoma, has been appointed chief exploitation engineer, and will be located in the office of the vice-president of production of the corporation at St. Louis, Missouri. W. M. MORRISON has been appointed to succeed Mr. Henson at Tulsa, as acting division exploitation engineer of the northern division.

D. R. SNOW, chief geologist of the Barnsdall Oil Company, has been elected vice-president in charge of geological and land departments of the company.

The Tulsa Geological Society, on April 18, presented the following program on "The Western Oklahoma Basin": F. C. GREENE, "Permian"; CHARLES RYNIKER, "Pennsylvanian"; G. S. DILLE, "Mississippian"; FANNY C. EDSON, "Pre-Mississippian"; and CLYDE BECKER, "Structural Trends and Compression Folds."

The Colorado School of Mines, Golden, Colorado, offers a summer course of six weeks in geophysical prospecting, including lectures, laboratory, and field work. Further information may be obtained from Professor C. A. HEILAND.

JEAN JUNG, of the University of Strasburg's oil section, has been appointed by the governor-general of French Equatorial Africa to take charge of research work for oil at Pointe-Noir and at Farnan-Vaz. Several wells are to be drilled when the geologic survey of the country is finished.

GEORGE S. BUCHANAN has moved to Wichita, Kansas. Mr. Buchanan is employed by the Tulsa Oil Company, which recently moved from Tulsa to the main offices of the Standard Oil Company of Kansas, Beacon Building, Wichita.

RALPH A. LIDDLE, geologist for the Pure Oil Company, Fort Worth, Texas, has a paper, "Outlines of Venezuelan Stratigraphy," in the April, 1932, issue of *Pan-American Geologist.*

ROBERT N. KOLM, Atlantic Oil Producing Company, has returned to Dallas, Texas, after spending some time in Matanzas, Cuba, for the same company.

ARTHUR J. TIEJE, chairman of the department of geology at the University of Southern California, will again give the courses in geology at the summer session of Columbia University. He will drive to New York in order to add to his collection of rock suites representing the historical geology of the states. Later he will spend a month in Europe collecting rocks.

STEPHEN H. ROOK, formerly with the Gulf Refining Company of Louisiana, may be addressed at 2226 Del Mar Road, Montrose, California.

CLIFTON R. SWARTS, petroleum engineer, has accepted a position with the Lago Petroleum Corporation, at Maracaibo, Venezuela, South America.

H. W. C. PROMMEL, recently returned to the United States from Russia, where he has been employed by the Russian government in research and exploratory work, addressed the Rocky Mountain Association of Petroleum Geologists at Denver, Colorado, April 18, on "Conditions in Russia."

J. P. SCHUMACHER, with the Torsion Balance Exploration Company, who has been in the Far East, Dutch East Indies, and Siam during the past year, has returned to the United States by way of Europe. His address is now 1028 Post-Dispatch Building, Houston, Texas.

Work has been commenced on the new $200,000 building which is to house the department of petroleum engineering, the engineering experiment station,

and the department of geology of the Texas Agricultural and Mechanical College at College Station, Texas.

The Alberta Society of Petroleum Geologists, Calgary, Alberta, held its annual meeting on January 29 and 30. The following papers were presented.

"Some Faulting Phenomena in the Alberta Foothills," by H. M. Hunter
"Refinement of Structure-Section Measurement by Planimeter," by B. F. Hake
"Notes on Foothills Structures," by R. Willis
"The Crowsnest Volcanics," by T. A. Link
"The Kootenay Section of Crowsnest Pass," by B. L. Thorne
"The Stratigraphy of the Colorado Formation of the Alberta Foothills," by R. Willis
"The Bearpaw of the Sullivan Lake-Battle River Region, Alberta," by D. L. Powers and Clare Clark
"Dynamic Metamorphic Effects on Natural Gas," by S. E. Slipper
"Geomagnetic Surveys in Alberta," by J. E. Duncan
"Brackish-Water Deposits," by J. O. G. Sanderson
"Well-Spacing Theory," by J. Dunn
"Limestone-Dolomite Relations in Turner Valley," by E. J. Van der Linden
"Study of Certain Stratigraphic Details of the Mesozoic of Southern Alberta," by C. C. Addison
"Origin of Lower Upper Cretaceous and Tertiary Redbeds in Southern Alberta," by J. O. G. Sanderson

ED. BLOESCH, consulting geologist of Tulsa, Oklahoma, is the author of a brief article, "Die Tiefste Bohrung der Vereinigten Staaten" (The Deepest Drill-Hole in the United States), in the *Petroleum Zeitschrift* of April 6.

JOSIAH BRIDGE, now of the United States National Museum at Washington, D. C., is the author of "The Geology of the Eminence and Cardareva Quadrangles," Volume 24 of the Missouri Bureau of Geology and Mines, at Rolla, Missouri.

H. A. BUEHLER, state geologist of Missouri, and H. S. MCQUEEN, assistant state geologist, presented papers on "Some Phases of Magnetometer Work in Missouri," and "Insoluble Residue Method," respectively, at the Tulsa Geological Society meeting, May 2.

The Bureau of Economic Geology, Austin, Texas, has in press a new bulletin, "The Geology of Texas," Vol. I, "Stratigraphy," by E. H. SELLARDS, W. S. ADKINS, and F. B. PLUMMER.

PHILIP B. KING, of the United States Geological Survey, is preparing a tectonic map of the United States for the sixteenth International Geological Congress.

The American Geographical Society, of New York, has published maps (scale—1:1,000,000) of the Tampico area, Mexico ("San Luis Potosi"), and of the Comodoro Rivadavia area, Argentina ("Comodoro Rivadavia"). The cost is $2.00 a sheet.

W. L. F. NUTTALL, formerly with the Cia Mexicana de Petroleo "El Aguila," S. A., Tampico, Mexico, is now with the Caribbean Petroleum Company, Maracaibo, Venezuela, South America.

N. C. Beck, formerly of Fort Worth, Texas, is now located at 1009 Spring Street, Tyler, Texas.

Paul Ruedemann, geologist, formerly of Tulsa, Oklahoma, is now in Austria and may be addressed, 39 Waltmamgasse, Vienna, XIII.

William E. Aitken, formerly of Brooklyn, New York, is now teaching geology at the University of Pittsburgh.

Robert H. Dott has opened a consulting office at 1502 Hunt Building, Tulsa.